A Strategic Plan for Spatial and Functional Integration of Wardha as a Twin city for Nagpur

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Master of Technology
In
Urban Planning

By

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I, Amit D. Patre, hereby declare that this thesis project titled **A Strategic Plan for Spatial and Functional Integration of Wardha as a Twin city for Nagpur** is carried out by me in the Department of Architecture & Planning of Visvesvaraya National Institute of Technology, Nagpur. The work is original and has not been submitted earlier whole or in part for the award of any degree/diploma at this or any other Institution / University.

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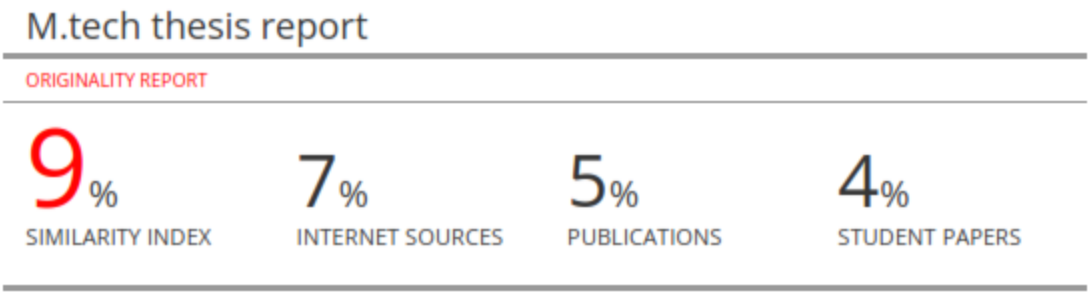

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ABSTRACT

As metropolitan regions across India face increasing urbanization and the concentration of economic activities, the urgency for regional decentralization and integrated urban planning has become more pronounced. This thesis presents a strategic framework for the spatial and functional integration of Wardha as a twin city to Nagpur, aiming to relieve the growing pressures on Nagpur by fostering a balanced and interdependent urban system.

The twin city model offers a promising approach to mitigating urban congestion, encouraging regional development, and promoting sustainable urbanization. This study examines the potential of Wardha to serve as a complementary urban center to Nagpur by utilizing GIS-based land suitability analysis, population forecasts, and public survey data. It identifies key infrastructural, economic and institutional factors essential for effective integration.

Focusing on the Wardha Metropolitan Region, the project analyzes existing transportation infrastructure, land use configurations, demographic shifts, and economic trends. Wardha emerges as a strategically positioned urban node with significant potential for infrastructural enhancement, multimodal transport integration, and institutional development. Core strategies proposed include the implementation of a Regional Mass Transit System (RMTS), metro line extensions, logistics-driven land use planning, and Transit-Oriented Development (TOD) to support compact, accessible, and sustainable urban growth.

Through a combination of GIS mapping, stakeholder engagement, and alignment with urban policies, the thesis outlines a phased roadmap for Wardha's evolution into a functionally autonomous yet regionally connected twin city. The findings contribute to the broader discourse on urban planning by illustrating how secondary cities can be

empowered to share metropolitan functions, support polycentric growth, and enhance regional resilience.

Keywords:

Twin City Development, Wardha–Nagpur Corridor, Peri-Urban Planning, Spatial Integration, Functional Integration, Urban Decentralization, Regional Planning, Transport Connectivity, Economic Clusters, Urban Development, Strategic Zoning, Growth Hub Initiative, Urban-Rural Linkages

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CHAPTER 1
INTRODUCTION

1.1 Overview

The concept of twin cities presents a compelling strategy for addressing urban congestion, stimulating regional growth, and promoting balanced development. This thesis explores the spatial and functional integration of Wardha as a twin city to Nagpur, leveraging the potential of peri-urban areas like Sindi and Butibori. Through detailed literature reviews, case studies (e.g., Surat–Navsari), GIS-based land suitability analysis, population projections, and public survey insights, the study identifies the key infrastructural, economic and institutional variables critical for successful integration. The findings emphasize the need for enhanced multimodal connectivity, decentralized planning, strategic zoning, and institutional coordination. The thesis proposes a vision and strategic framework that aligns with national growth initiatives and public aspirations, aiming to transform Wardha into a resilient and complementary urban counterpart to Nagpur.

1.2 Background

Definition of Twin Cities

Twin cities refer to two adjacent urban centers that cultivate interconnected economies, infrastructure, or governance frameworks while maintaining distinct municipal identities. These cities typically evolve in close geographical proximity and demonstrate a high degree of interdependence across social, economic, and administrative dimensions.

A classic international example is the **Twin Cities of Minneapolis and Saint Paul** in Minnesota, USA. These cities, although separate municipalities, operate synergistically by sharing public resources and infrastructural systems, forming a cohesive metropolitan region [1].

Key Aspects of Twin Cities

The concept of twin cities encompasses the following key characteristics:

- **Proximity**: Twin cities are geographically close, often within commuting distance, which facilitates physical and economic connectivity.
- **Interdependence**: They maintain strong ties in terms of economy, culture, social institutions, and labor markets.
- **Shared Resources**: Infrastructure such as transportation networks, utilities, and urban services are often shared to maximize efficiency.
- **Distinct Identities**: Despite being functionally linked, each city retains its own unique administrative structure, cultural fabric, and governance model.

These features support coordinated growth while preserving localized identity and governance.

Examples of Twin Cities

To understand the twin city model more comprehensively, the following global case studies are illustrative:

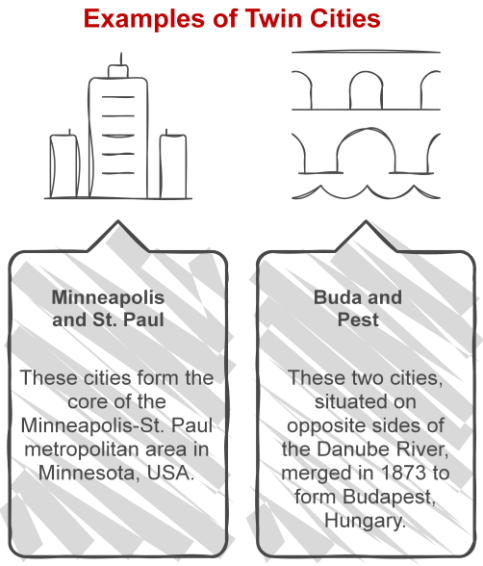
Examples of Twin Cities
Minneapolis and St. Paul
These cities form the core of the Minneapolis-St. Paul metropolitan area in Minnesota, USA.
Buda and Pest
These two cities, situated on opposite sides of the Danube River, merged in 1873 to form Budapest, Hungary.

Figure 1 Renowned Twin City Examples

- **Minneapolis and St. Paul, USA**: Commonly known as the “Twin Cities,” they serve as the principal metropolitan area of Minnesota. Their development highlights the benefit of shared infrastructure and economic synergy.
- **Buda and Pest, Hungary**: These two cities were situated on opposite banks of the Danube River and were administratively merged in 1873 to form **Budapest**, now the capital of Hungary. This historical example shows how twin cities can evolve into a unified metropolitan entity while retaining their historic roots.[1]

Indian Twin Cities: Case Studies and Spatial Patterns

India, with its vast and diverse urban fabric, has witnessed the development of numerous twin cities across different states. These urban pairs have evolved due to historical, economic, administrative, and planning considerations. Many of these city duos exemplify successful functional and spatial integration while maintaining their distinct identities [2].

Notable Indian Twin Cities:

1. **Hyderabad – Secunderabad (Telangana)**: Often called the "twin cities" of southern India, these two urban centers have merged physically due to urban sprawl but are still distinct in terms of historical evolution—Hyderabad with its princely legacy and Secunderabad as a cantonment.
2. **Kolkata – Howrah (West Bengal)**: Separated by the Hooghly River, this pair functions as a singular economic unit. The iconic Howrah Bridge physically connects them, symbolizing their urban interdependence.
3. **Ahmedabad – Gandhinagar (Gujarat)**: Ahmedabad is Gujarat’s commercial capital, while Gandhinagar is the planned administrative capital. Together, they offer a dynamic mix of industry, education, and governance.
4. **Cuttack – Bhubaneswar (Odisha)**: While Cuttack is an ancient trading hub and judicial capital, Bhubaneswar is a planned capital city. The cities are functionally complementary and serve as twin urban nodes for the state.

5. **Pune – Pimpri-Chinchwad (Maharashtra)**: These neighboring cities form a major industrial and educational hub in western India, integrated via transport and planning frameworks under the Pune Metropolitan Region Development Authority (PMRDA).
6. **Kochi – Ernakulam (Kerala)**: Kochi, with its port and historical center, pairs with Ernakulam, the more modern commercial core. Together, they form Kerala's urban backbone.
7. **Surat – Navsari (Gujarat)**: Located in southern Gujarat, these two cities share cultural ties and economic activities, especially in textiles and diamond processing [2].

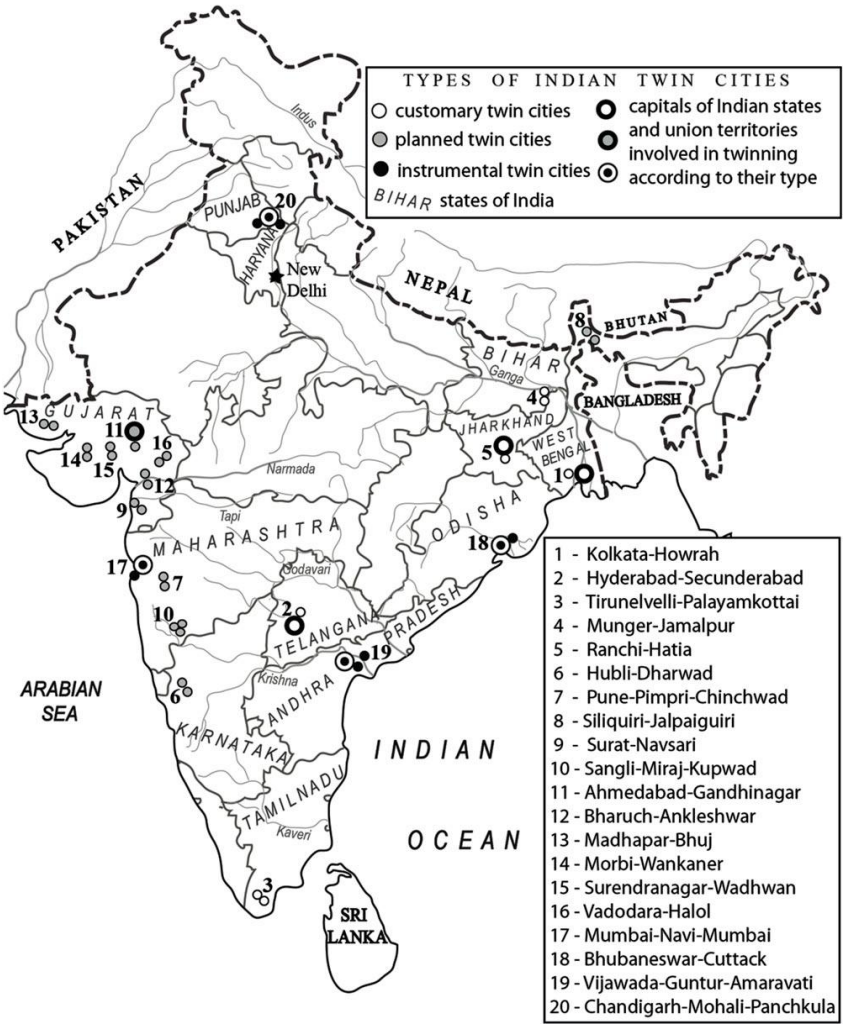

Figure 2 Map showing types and location of Indian Twin City

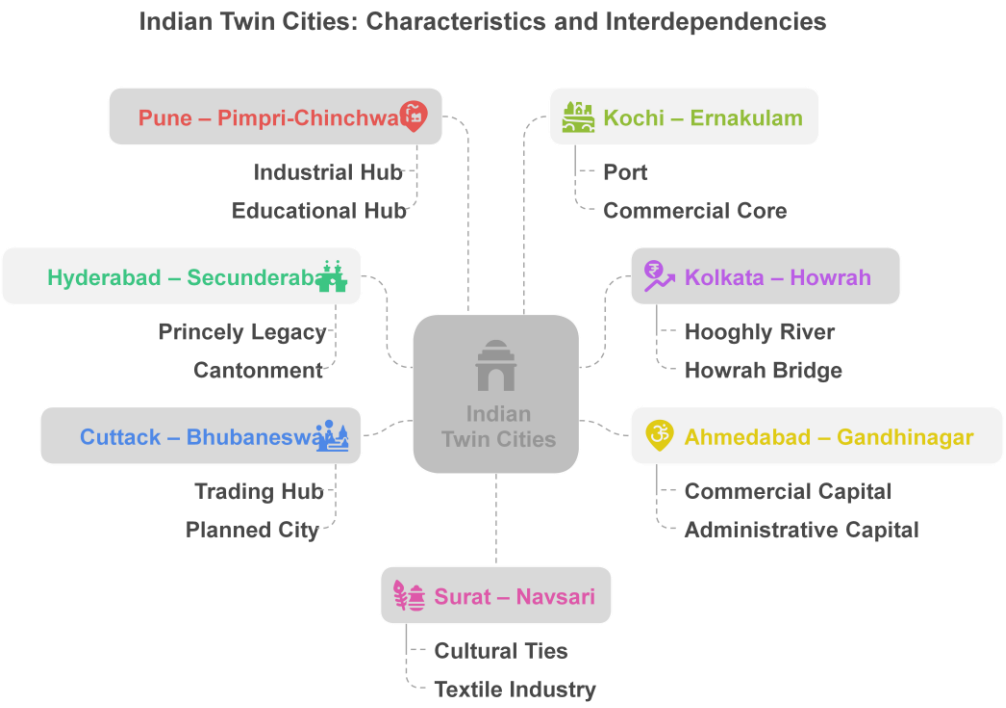

Figure 3 Indian Twin Cities with Character

Spatial Distribution of Twin Cities in India

India's twin cities exhibit diverse typologies, as shown in the figure above, based on functional typology—planned, customary, or instrumental. These cities often emerge due to geographical proximity and complementary functions.

These examples provide critical insights into how twin city models can be successfully implemented in India. Such cases set the precedent for exploring **Wardha-Nagpur** as a potential twin city pair.

1.3 Need of Study

Nagpur, as a major metropolitan hub in central India, is experiencing rapid urbanization, population growth, and increasing pressure on its infrastructure, services, and resources.

This has led to spatial congestion, rising land costs, environmental stress, and challenges in equitable development. To mitigate these issues and promote balanced regional growth, there is a pressing need to explore sustainable urban expansion strategies.

Wardha, located approximately 70 km from Nagpur, presents an ideal opportunity for decentralizing development through the twin city model. Its strategic location along national highways and rail corridors, coupled with emerging industrial zones in Butibori and logistics hubs in Sindi, provides a natural foundation for regional integration. However, uncoordinated growth, fragmented planning, and underutilized land and infrastructure continue to limit Wardha's developmental potential.

This study is essential to:

- **Assess the spatial and functional readiness of Wardha** to operate as a twin city by analyzing land use, infrastructure, and connectivity.
- **Identify peri-urban transformation trends** and emerging economic corridors that can bridge the urban-rural divide between Nagpur and Wardha.
- **Develop a strategic planning framework** that integrates GIS-based land suitability analysis, transportation planning, and zoning regulations to guide future development.
- **Incorporate community perspectives and policy recommendations** to ensure the plan is inclusive and aligned with regional aspirations.
- **Propose actionable interventions** that align with national urbanization initiatives such as the G-Hub model and Viksit Bharat 2047 vision.

Ultimately, this study is needed to transform Wardha from a peripheral town into a dynamic urban counterpart that complements Nagpur's growth while fostering a balanced and resilient metropolitan region.

1.4 Inferences from Phase – 1

Peri-Urban Transformation and Strategic Opportunity

Unlocking the Twin City Potential

The nodes like **Sindi** and **Butibori**, located between Nagpur and Wardha, represent critical spatial corridors experiencing accelerated transformation. These regions have shown significant growth due to:

- **Urbanization** driven by proximity to Nagpur,
- **Industrialization**, notably in Butibori (a designated 5-star MIDC zone),
- **Improved connectivity** through road and rail infrastructure, especially along the **Wardha-Nagpur corridor**.

Sindi has emerged as a **logistics hub**, while **Butibori** functions as a major **industrial estate**, forming vital economic nodes between the two cities. These factors highlight the readiness of these zones to act as bridging peripheries that support the functional integration necessary for twin city development.

Urban Planning Strategy for Wardha-Nagpur Integration

City twinning has emerged as a **progressive urban planning strategy** in India, encouraging cooperative governance, economic collaboration, and shared infrastructural development. Drawing from successful twin city models, the Wardha-Nagpur pairing must focus on the **peri-urban continuum** to unlock mutual growth potential.

To strategically position **Wardha as a Twin City to Nagpur**, a holistic planning approach is necessary, with key focus areas including:

- **Infrastructure Enhancement**: Improved transportation, logistics, and utility services.
- **Economic Integration**: Leveraging industrial nodes and labor mobility.
- **Urban planning and Governance**: Coordinated master planning that transcends administrative boundaries.
- **Cultural and Social Linkages**: Facilitating integration while preserving regional identities.

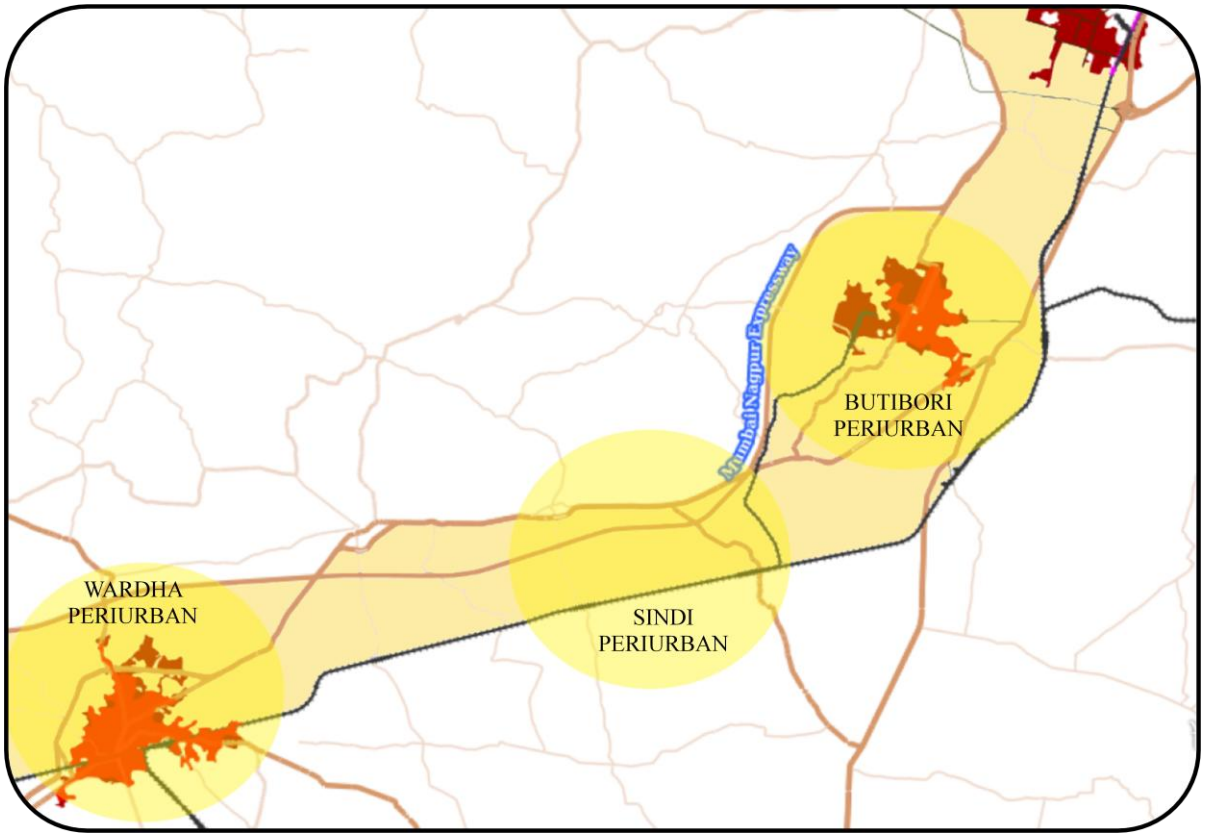

Figure 4 Peri-Urban Growth Zones along the Nagpur–Wardha Corridor

By targeting these growth centres for coordinated development, the Wardha-Nagpur region can evolve into a cohesive metropolitan system, emulating the synergy found in other successful Indian and global twin cities.

1.5 Opportunities and Constraints in the Wardha-Nagpur Twin City Framework

Strategic Potential: Benefits of Twin City Integration

The integration of Wardha as a twin city to Nagpur presents a range of **potential benefits** that align with urban decentralization, balanced regional development, and economic synergy:

1. Decongestion of Nagpur

- **Overburdened Infrastructure**: Nagpur's rapid growth has strained its urban infrastructure.
- **Balanced Urban Growth**: A twin city model allows for managed urban sprawl and equitable distribution of population and services.

2. Economic Growth and Industrial Expansion

- **Industrial Development**: The peri-urban regions of Butibori and Sindi can serve as industrial and logistics zones.
- **Agri-Business and Rural Development**: Economic spillover into rural areas can boost agro-industrial linkages and diversify livelihoods.

3. Improved Infrastructure and Connectivity

- **Enhanced Transport Networks**: Strengthening road, rail, and freight systems between Wardha and Nagpur.
- **Shared Infrastructure**: Integrated urban systems for utilities and public services across the corridor.

4. Social and Educational Opportunities

- **Educational Hubs**: Wardha can be further developed as an academic and skill-development zone, reducing pressure on Nagpur's institutions.

Strategic Constraints: Potential Challenges in Implementation

Despite its potential, the twin city model faces **critical challenges** that must be addressed to ensure successful integration:

1. Governance and Policy Coordination

- **Policy and Planning Alignment**: Diverging development frameworks and administrative silos between city authorities.
- **Competing Interests**: Regional politics and conflicting stakeholder priorities may hinder cohesive planning.

2. Infrastructure and Connectivity Gaps

- **Limited Connectivity**: Inadequate current infrastructure for seamless urban flow.
- **Dependence on Nagpur**: Over-reliance on Nagpur's systems limits Wardha's autonomy and resilience.

3. Environmental and Land Use Issues

- **Loss of Agricultural Land**: Urban expansion may compromise fertile farmland.
- **Environmental Degradation**: Unchecked development risks harming the ecological balance in peri-urban regions.

4. Pressure on Local Resources

- **Water and Waste Management**: Existing systems may not support expanded urbanization without investment.
- **Sustainability of Resources**: Over extraction and overuse could lead to long-term resource insecurity.

Incorporating these insights into the broader planning framework is crucial for crafting an implementable and resilient strategy for twin city development. The next phases of the study will focus on mitigating these challenges through targeted interventions in governance, land use planning, and infrastructure investment.

1.6 Synopsis of the Study

Aim

Developing a strategic plan ensuring the integration of the Wardha peri-urban area into the overall development strategy for spatial and functional integration of Wardha as a Twin city for Nagpur

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Objectives

To achieve this aim, the study is guided by the following objectives:

- **Identify potential synergies** and collaborative opportunities in the domains of transportation and infrastructure between Wardha and Nagpur, with special emphasis on the peri-urban zones.
- **Address infrastructural inadequacies** by proposing targeted solutions aimed at improving service delivery and promoting **efficient resource management** in the region.
- **Formulate a strategic urban development plan** for Wardha as a twin city to Nagpur, taking into account key elements such as **transportation networks, land use planning**, and alignment with existing peri-urban development schemes.

Scope

The scope of this research will be limited to the metropolitant areas of Wardha, with a specific focus on the integration of Wardha's peri-urban area into the twin city for Nagpur.

1.7 Study Limitations and Research Questions

Limitations of the Study

Despite the comprehensive approach undertaken, this study acknowledges certain inherent limitations that may influence the depth and accuracy of findings:

- The study may be limited by the availability and accuracy of secondary data, particularly data related to the implementation of the peri-urban plan.
- Accurate data on informal settlements within the peri-urban area of Wardha may be difficult to obtain, potentially leading to an incomplete understanding of the socio-economic dynamics and spatial realities.

These limitations highlight the importance of contextualizing recommendations within the framework of data availability and the evolving urban fabric.

Research Questions

The investigation is guided by the following core research questions:

1. **Integration of Physical Development Plans**
   How can the physical development plan of Wardha's peri-urban area be integrated and enhanced to support the development of a successful twin city model?
2. **Key Elements of a Twin City Model**
   What are the essential components of a successful twin city model, particularly with respect to transportation and infrastructure, and how does the peri-urban plan contribute to realizing these elements?
3. **Institutional and Governance Frameworks**
   What institutional and governance mechanisms are required to implement and manage the twin city model effectively, while ensuring the integration of peri-urban development strategies into the broader urban planning process?

These questions form the foundation of the analytical framework and guide the direction of strategic recommendations proposed in later phases of the study.

1.8 Research Methodology

1.8.1 Background Study and Need Assessment

The study began with an in-depth background study and contextual analysis of the urban and peri-urban interface between Wardha and Nagpur. This included:

- Understanding the concept and significance of **peri-urban areas**.
- Reviewing the existing **planning framework and institutional structures** governing the peri-urban region.
- Establishing the **need for a twin city strategy** through problem identification and gap analysis.

1.8.2 Literature Review and Case Studies

A detailed review of national and international literature was conducted to:

- Understand theoretical perspectives on **peri-urban integration**, twin cities, and regional planning.
- Identify **indicators and parameters** relevant to infrastructure, governance, and spatial integration.
- Study successful case studies of similar **twin city or satellite town models** to draw key lessons.

1.8.3 Identification and Delineation

This phase involved:

- Delineating the **urban periphery of Wardha** based on spatial growth, administrative boundaries, and development trends.
- Identifying the **various planning bodies** operating in the urban and peri-urban regions and their roles.

1.8.4 Indicator and Parameter Development

- Indicators were developed to evaluate spatial, infrastructure, governance, and socio-economic aspects of peri-urban integration.
- Parameters and **assessment methods** were selected to enable data analysis across these indicators.

1.8.5 Area Selection and Data Collection

A representative study area within the peri-urban belt of Wardha was selected for detailed analysis. Data was collected through:

- **Primary Data**: Conducted through site visits, stakeholder interviews, and structured **questionnaire surveys** targeting local residents, planners, and officials.
- **Secondary Data**: Sourced from official reports, development plans, **Census 2011**, policy documents, and institutional databases.

1.8.6 Data Processing and Indicator Analysis

- Data from both primary and secondary sources were systematically compiled and **processed**.
- A comprehensive **indicator-based analysis** was performed to evaluate the existing conditions and identify critical gaps.

1.8.7 Representation and Proposal Formulation

- Observations were **represented spatially and statistically** to provide a comprehensive picture of the current scenario.
- Based on this, strategic **planning proposals** were developed for the spatial and functional integration of Wardha as a twin city to Nagpur.

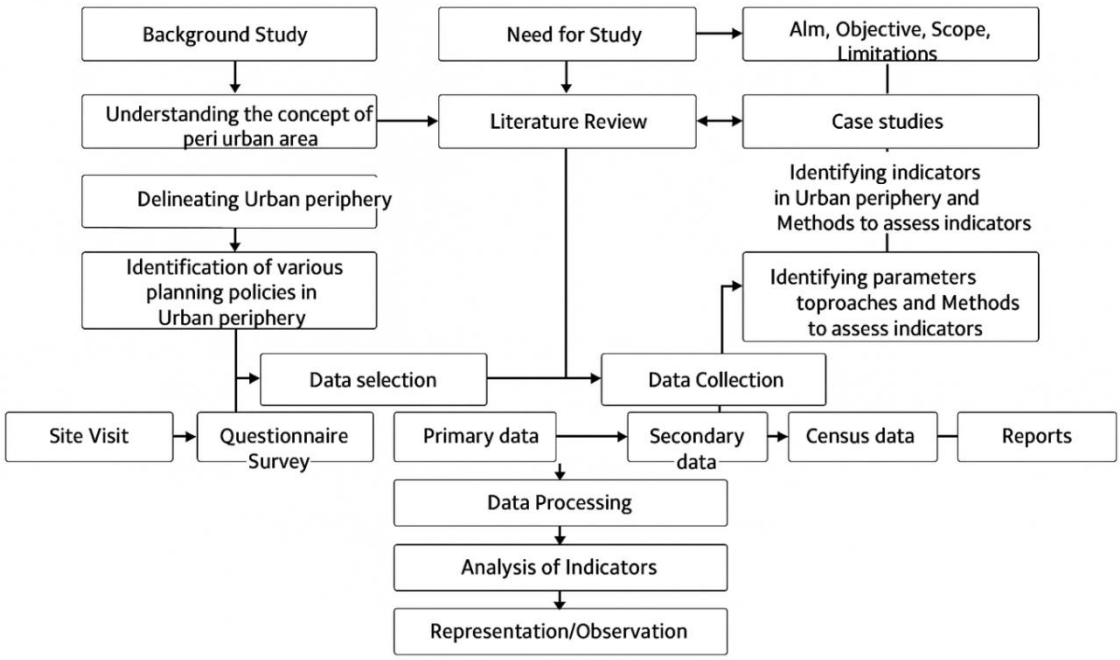


Figure 5 Methodology Flowchart

CHAPTER 2
LITERATURE REVIEW

2.1 Research Paper Study

Sr. No.	Case Study Title	Indicators	Inference
1	Metropolitan and Peri Urban Governance in India: Case Study of Chennai Metropolitan Area[3]	- Expansion of municipal boundaries - Multi-institutional governance - Participatory decision-making - Delegation of financial powers - Integration of villages into urban limits	The governance model in Chennai demonstrates the need for integrated, participatory, and decentralized planning to manage rapid urban expansion and deliver essential services effectively
2	Analysing Dynamics between Various Planning Bodies in Indian System of Governance, a case of Nagpur Metropolitan Area[4]	- Overlapping jurisdictions - Lack of coordination - Citizen and expert surveys - Use of Analytical Hierarchy Process (AHP)	Multiple planning bodies with overlapping roles hinder effective governance; improved coordination and clear delineation of responsibilities are needed for efficient urban management
3	India's Peri-Urban Regions: The Need for Policy and the Challenges of Governance[5]	- Unregulated development - Fragmented planning - Lack of statutory plans - Inadequate services - Forced land acquisition - Policy initiatives for integration	Peri-urban areas face challenges due to fragmented governance, lack of regulation, and insufficient services; policy reforms must focus on integrated planning, regulatory frameworks, and inclusion of peri-urban areas in urban governance
4	Monitoring Spatio-Temporal Dynamics of Urban and Peri-Urban Landscape Using Remote Sensing and GIS – A Case Study from Central India[6]	- Land use/land cover (LULC) change - Remote sensing and GIS analysis - Urban expansion patterns	Remote sensing and GIS are effective for monitoring dynamic land use changes in peri-urban areas, providing critical data for planning and managing urban growth
5	Redefining Peri-Urban Urban Areas[7]	- Definition parameters: population, density, economic activity, connectivity - Dynamic extent of peri-urban areas - Need for clear delineation	Peri-urban areas are transitional, dynamic, and require clear, context-specific definitions using multi-factor indicators for effective planning and integration with urban areas
6	Conflictual interplay between rural and urban areas: demarcation of peri-Urban areas and challenges in	- Rural-urban interface - Demarcation challenges - Planning conflicts	Conflicts arise from unclear boundaries and competing interests at the rural-urban fringe; precise demarcation and participatory planning are essential for conflict resolution (inferred from general peri-urban literature).

	Planning, the case of Izmir[8]		
7	What is the most suitable methodological approach to demarcate peri-urban areas? A systematic review of the literature[9]	- Review of demarcation methods - Use of multi-indicator systems - Spatial and socio-economic data	Systematic reviews highlight the need for multi-indicator, data-driven approaches (e.g., GIS, AHP) to accurately delineate peri-urban areas.
8	Simulation of land use changes for the planning of a metropolitan area[10]	- Land use change modeling - Scenario analysis - Planning support tools	Simulation models help anticipate urban expansion and inform proactive planning strategies for metropolitan growth (general knowledge).
9	Planning on the edge: England's rural ^ urban fringe and the spatial-planning agenda[11]	- Rural-urban fringe management - Spatial planning policies - Edge development issues	Effective spatial planning at the urban fringe requires balancing urban growth with rural preservation and clear policy frameworks (general knowledge).
10	Assessment of land suitability potentials for future development – A case study of Bharuch - Ankleshwar twin cities through GIS[12]	- GIS-based land suitability analysis - Multi-criteria evaluation - Urban expansion potential	GIS and multi-criteria analysis are valuable for identifying suitable areas for urban expansion, supporting informed decision-making.
11	Comparative study of quantitative identification methods for periurban areas based on a multi indicator system[13]	- Quantitative methods - Multi-indicator systems - Comparative analysis	Multi-indicator quantitative methods improve the accuracy and consistency of peri-urban area identification.
12	Peri-urban area delineation and urban sprawl quantification in Thiruvananthapuram Urban Agglomeration, India, from 2001 to 2021 using geoinformatics[14]	- Geoinformatics - Urban sprawl measurement - Temporal analysis	Geoinformatics enables precise delineation and monitoring of peri-urban expansion over time, aiding urban management.
13	Where Is the Peri-Urban? A Systematic Review of Peri-Urban Research and Approaches for Its Identification and Demarcation	- Literature review - Identification and demarcation approaches - Global perspectives	Diverse global approaches exist; best practice combines spatial, socio-economic, and participatory indicators for peri-urban delineation.

	Worldwide[15]		
14	Peri-urban Delineation and Urban Expansion Quantification from 2001 to 2021 of Hisar City, India, using Geospatial Techniques[16]	- Geospatial analysis - Urban expansion quantification - Temporal change detection	Geospatial techniques are effective for tracking urban expansion and delineating peri-urban boundaries.
15	Local Area Planning for Urban Periphery: A Case of Bhairopur Area, Bhopal[17]	- Local area planning - Urban periphery development - Stakeholder engagement	Local area planning at the urban periphery ensures balanced development and addresses peri-urban challenges through stakeholder participation.
16	Planning Peri-Urban Open Spaces: Methods and Tools for Interpretation and Classification[18]	- Open space planning - Interpretation and classification tools - Peri-urban context	Specialized tools and methods are needed for effective planning and management of peri-urban open spaces.
17	Land Suitability Assessment for Agriculture Using Analytical Hierarchy Process and Weighted Overlay Analysis in ArcGIS ModelBuilder[19]	- Analytical Hierarchy Process (AHP) - Weighted overlay analysis - Agricultural land suitability	AHP and GIS-based weighted overlay methods provide robust frameworks for assessing land suitability in peri-urban and rural contexts.
18	A novel approach for assessing watershed susceptibility using weighted overlay and analytical hierarchy process (AHP) methodology: a case study in Eagle Creek Watershed, USA[20]	- Watershed susceptibility - Weighted overlay and AHP - Case study application	Weighted overlay and AHP are effective for environmental assessment and planning, applicable to peri-urban land management.
19	Application of the overlay weighted model to determine the best locations for expansion of Adigrat town[21]	- Overlay weighted model - Urban expansion site selection - GIS application	Overlay weighted models in GIS help identify optimal sites for urban expansion, supporting sustainable peri-urban growth.
20	A GIS-based Analysis for Selecting Ground Infrastructure Locations for Urban Air Mobility[22]	- GIS-based location analysis - Urban air mobility infrastructure - Spatial decision-making	GIS-based analysis supports strategic infrastructure planning in urban and peri-urban areas.
21	Analytic hierarchy process in	- AHP in transportation - Decision-making trends	AHP is widely used for complex decision-making in urban and peri-urban transportation

	transportation decision-making: A two-staged review on the themes and trends of two decades[23]	- Thematic review	planning.
22	Application of GIS and AHP for land use suitability analysis: case of Demirci district (Turkey)[24]	- GIS and AHP integration - Land use suitability - Case study approach	Integrating GIS and AHP enhances land use suitability assessments, providing a replicable model for peri-urban planning.

Table 1 Research Paper Analysis

2.2 Findings and Indicator Framework from research papers

In order to formulate a strategic plan for the spatial and functional integration of Wardha as a twin city to Nagpur, a comprehensive analysis of existing case studies was undertaken. These findings helped establish a set of context-specific **indicators** under major thematic **categories** to evaluate peri-urban integration potential and challenges.

Key Indicator Categories and Findings

The following indicators were derived from the synthesis of successful national and international twin city and peri-urban development models. They were adapted for application in the Wardha context to assess physical, socio-economic, infrastructural, environmental, and institutional conditions.

1. Proximity to Urban Core

- **Distance from Urban Core**: Evaluates physical separation and its effect on connectivity and development.
- **Travel Time (Nagpur to Wardha)**: Time-efficiency in transportation influences commuting patterns.
- **Connectivity to Urban Centers**: Assesses strength of road, rail, and transit links with Nagpur.

2. Existing and Planned Infrastructure

- **Transport Infrastructure**: Includes highways, metro/BRT systems, and regional corridors like Samruddhi Mahamarg.
- **Utilities and Public Services**: Access to water, electricity, broadband, and sewage systems.
- **Urban Master Plans**: Presence and quality of planning documents guiding future growth.

3. Population Growth and Demographics

- **Current Population Density**: Helps in understanding the present spatial pressures.
- **Population Growth Projections**: Future planning depends on anticipated demographic trends.
- **Migration Patterns**: Tracks rural-to-urban movement affecting land use and service demand.

4. Land Use and Zoning

- **Emerging Urban Land Uses**: Trends in residential, commercial, and industrial developments.
- **Land Use Compatibility**: Examines alignment of land use with zoning policies.
- **Agricultural Land Transition**: Shift from agriculture to urban usage and its implications.

5. Economic Activities and Employment

- **Emerging Economic Hubs**: New zones of light industry or commercial growth.
- **Industrial and Commercial Clusters**: Presence of established or planned clusters.
- **Employment Centers**: Location and type of employment opportunities (e.g., retail, manufacturing).

6. Environmental and Ecological Considerations

- **Environmental Sensitivity**: Protection of wetlands, forests, and ecologically fragile areas.
- **Green Space Integration**: Parks and recreational open spaces within urban design.
- **Flood Zones or Hazardous Areas**: Identification of risk-prone zones.
- **Resource Availability**: Access to water, energy, and land.

7. Social Infrastructure

- **Education and Healthcare Access**: Availability and quality of schools and hospitals.
- **Public Amenities**: Parks, recreation centers, libraries, etc.
- **Social Services Integration**: Presence of welfare and social development programs.

8. Public Opinion and Community Engagement

- **Community Needs and Feedback**: Involves participatory feedback from local residents.
- **Local Support for Urbanization**: Measures acceptance and resistance toward urban development projects.

Category	Indicator
Proximity to Urban Core	○ Distance from Urban Core ○ Travel time nagpur to wardha 45 min ○ Connectivity to Urban Centers (transportation networks)
Existing and Planned Infrastructure	○ Transport Infrastructure (roads, rail, metro, BRT)(Sammrudhi, National Highway, State Highway) ○ Utilities and Public Services (water, sewer, electricity, broadband) ○ Urban Master Plans for expansion
Population Growth and Demographics	○ Current Population Density ○ Population Growth Projections ○ Migration Patterns (rural to urban)
Land Use and Zoning	○ Emerging Urban Land Uses (residential, commercial, industrial)

	○ Land Use Compatibility (zoning regulations) ○ Agricultural Land Transition (agriculture to urban)
Economic Activities and Employment	○ Emerging Economic Hubs (light industry, commercial sectors) ○ Industrial and Commercial Clusters ○ Employment Centers (retail, services, manufacturing)
Environmental and Ecological Considerations	○ Environmental Sensitivity (e.g., wetlands, forests) ○ Green Space Integration (parks, recreational areas) ○ Flood Zones or Hazardous Areas (risk zones) ○ Resources availability (water, energy, land)
Social Infrastructure	○ Education and Healthcare Access (schools, hospitals) ○ Public Amenities (parks, recreational centers) ○ Social Services Integration (welfare services)
Public Opinion and Community Stakeholder Engagement	○ Community Needs and Feedback (engagement with local residents) ○ Local Support for Urbanization (acceptance of development projects)

Table 2 Indicators Derived from Research Paper Study Analysis

Category	Indicator	Grade	Condition
Proximity to Urban Core	- Distance from Urban Core	1	Very far, poor connectivity
	- Connectivity to Urban Centers (transportation networks)	2	Relatively far, limited connectivity
		3	Moderate distance, fair connectivity
		4	Close, good connectivity
		5	Very close, excellent connectivity
Existing and Planned Infrastructure	- Transport Infrastructure (roads, rail, metro, BRT)	1	No infrastructure, no plans
	- Utilities and Public Services (water, sewer, electricity, broadband)	2	Basic infrastructure, limited future plans
	- Urban Master Plans for expansion	3	Moderate infrastructure, some planned expansions
		4	Advanced infrastructure, substantial future plans
		5	Well-developed infrastructure, comprehensive plans in place
Population Growth and Demographics	- Current Population Density	1	Low population, declining growth
	- Population Growth Projections	2	Moderate population, slow growth
	- Migration Patterns (rural to urban)	3	High population, steady growth
		4	Very high population, rapid growth
		5	Overcrowded, highly rapid growth
Land Use and Zoning	- Emerging Urban Land Uses (residential, commercial, industrial)	1	Predominantly rural, no zoning changes
	- Land Use Compatibility (zoning regulations)	2	Limited land use changes, restrictive zoning
	- Agricultural Land Transition (agriculture to urban)	3	Mixed land use, some zoning flexibility
		4	Significant land use transformation, favorable zoning

		5	Predominantly urbanizing, highly flexible zoning
Economic Activities and Employment	- Emerging Economic Hubs (light industry, commercial sectors)	1	No economic activities or hubs
	- Industrial and Commercial Clusters	2	Small-scale economic activities
	- Employment Centers (retail, services, manufacturing)	3	Moderate economic activities, some employment growth
		4	Well-developed economic hubs, substantial employment
		5	Major economic centers, high employment generation
Environmental and Ecological Considerations	- Environmental Sensitivity (e.g., wetlands, forests)	1	Highly sensitive, severe environmental risks
	- Green Space Integration (parks, recreational areas)	2	Moderate environmental sensitivity, some risk zones
	- Flood Zones or Hazardous Areas (risk zones)	3	Low sensitivity, manageable risks
	resources availability (water, energy and land)	4	Little environmental risk, good green space
		5	Very low sensitivity, well-integrated green spaces
Social Infrastructure	- Education and Healthcare Access (schools, hospitals)	1	No social infrastructure, no services
	- Public Amenities (parks, recreational centers)	2	Basic infrastructure, limited services
	- Social Services Integration (welfare services)	3	Adequate services, moderate accessibility
		4	Good infrastructure and accessibility
		5	Comprehensive services, high accessibility
Public Opinion and Community Stakeholder Engagement	- Community Needs and Feedback (engagement with local residents)	1	Strong opposition, no engagement
	- Local Support for Urbanization (acceptance of development projects)	2	Some opposition, limited engagement
		3	Moderate support, some engagement
		4	High support, good engagement
		5	Full support, excellent engagement

Table 3 Gradation to Indicators

Grading System Explanation:

- **1**: **Poor** – The indicator is not met, or conditions are unfavorable for expansion.
- **2**: **Limited** – The indicator is partially met, but conditions require significant improvement.
- **3**: **Moderate** – The indicator is reasonably met, and conditions are fair for development.
- **4**: **Good** – The indicator is mostly met, and conditions are favorable for development.

- **5**: **Excellent** – The indicator is fully met, and conditions are optimal for urban expansion.

2.3 Literature study

2.3.1 Understanding Peri-Urban Areas

Peri-urban areas represent transitional zones where urban and rural characteristics co-exist and interact. These zones are typically located at the peripheries of metropolitan regions and are characterized by their dynamic nature, undergoing constant transformation due to the pressures of urbanization. These landscapes are marked by a blend of agricultural, residential, commercial, and industrial activities. They serve as important buffers between densely urbanized cores and rural hinterlands.[25]

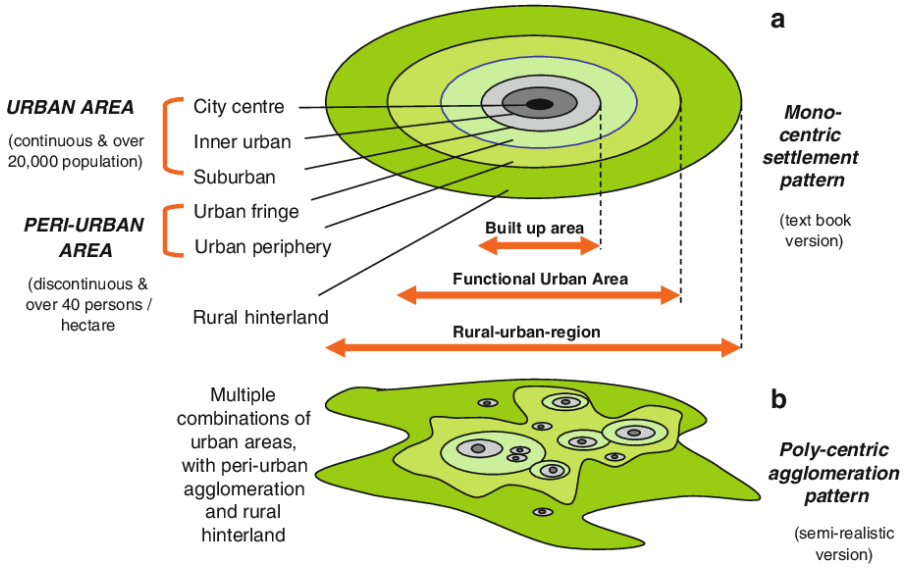


Figure 6 Periurban Areas

2.3.2 Concepts and Terminologies of Peri-Urban Zones

To understand the functioning and morphology of peri-urban areas, it is essential to study key conceptual frameworks:

- **Fringe Belts**: As defined by Thomas, fringe belts are mixed-use zones located at the edges of urban areas. They typically encompass residential, commercial, industrial uses along with open and agricultural lands.
- **Desakota**: Coined by McGee, this term (a blend of the Indonesian words desa for village and kota for city) refers to densely populated areas with interwoven urban and agricultural activities, particularly common in Southeast Asia. It underscores the blurred boundaries and economic interdependencies in peri-urban regions.
- **Edge City**: Introduced by Garreau, this concept highlights new, sprawling developments of office and retail space beyond traditional downtowns. Though not strictly peri-urban, such areas often emerge within peri-urban zones, emphasizing decentralized growth.

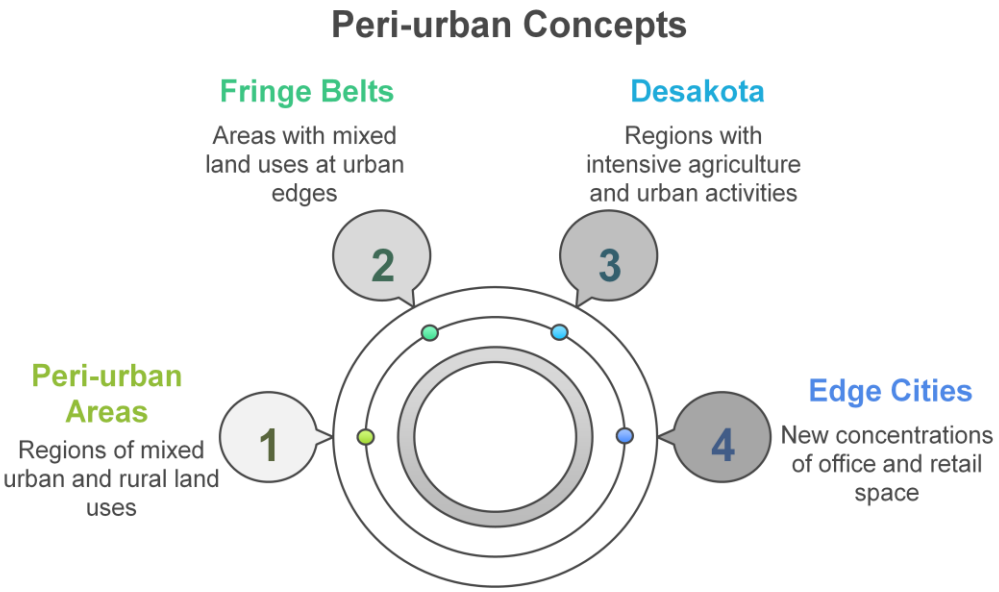


Figure 7 Periurban Terminologies

Land Use	Urban Areas	Peri-Urban Areas	Rural Areas
Dominant Land Use	High-density residential, commercial, industrial, and institutional uses.	Mixed uses; transition between urban and rural, including agriculture, residential, commercial, and open space.	Primarily agricultural, forestry, and other natural resource-based activities; low-density residential areas.
Density	High population and building density.	Lower density than urban areas, but higher than rural areas; often characterized by sprawl.	Low population and building density.

Land Use	Urban Areas	Peri-Urban Areas	Rural Areas
Infrastructure	Well-developed infrastructure: roads, public transport, utilities, services.	Developing infrastructure; may have gaps in services and connectivity.	Limited infrastructure; often reliant on individual systems (e.g., wells, septic tanks).
Economic Activities	Primarily service-based, commercial, and industrial.	A mix of agriculture, industry, and services; often a location for warehousing and distribution.	Primarily agriculture, forestry, mining, and tourism.
Open Space	Limited open space, mainly parks and recreational areas.	Significant open space, including agricultural land, green belts, and natural areas interspersed with development.	Large areas of open space, including farmland, forests, and natural habitats.
Land Use Planning	Generally strong land use planning and zoning regulations.	Land use planning can be fragmented and inconsistent, leading to conflicts between different land uses.	Land use planning may be limited or focused on preserving agricultural land and natural resources.

Table 4 Key differences in land use between periurban, urban, and rural areas

2.3.3 Social Characteristics of Peri-Urban Areas

Socially, peri-urban areas are marked by a diverse population mix including long-term rural residents and urban newcomers. This mix leads to:

- **Diverse Population**: A convergence of socioeconomic backgrounds and cultural identities.
- **Changing Dynamics**: Community transformations due to migration, leading to shifts in social interactions and traditions.
- **Service Accessibility**: Inconsistent access to healthcare, education, and transit based on infrastructural development.
- **Commuting Patterns**: Daily commutes to urban centers for employment, education, and services shape transportation flows.
- **Environmental Issues**: Pollution, traffic congestion, and habitat loss emerge due to rapid, unplanned development.
- **Social Interaction**: The integration of diverse communities presents both challenges and opportunities for cohesion and trust-building.

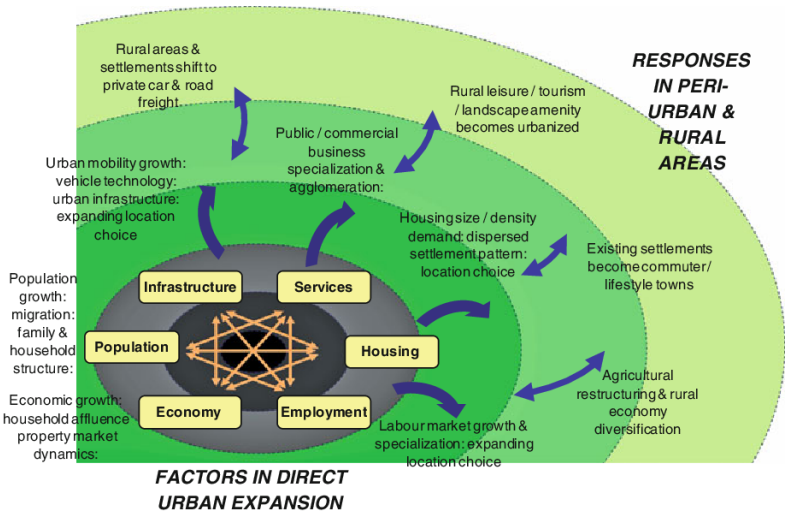

Rural areas & settlements shift to private car & road freight
RESPONSES IN PERI-URBAN & RURAL AREAS
Rural leisure / tourism / landscape amenity becomes urbanized
Public / commercial business specialization & agglomeration:
Urban mobility growth: vehicle technology: urban infrastructure: expanding location choice
Housing size / density demand: dispersed settlement pattern: location choice
Existing settlements become commuter/ lifestyle towns
Population growth: migration: family & household structure:
Infrastructure
Services
Population
Housing
Economy
Employment
Agricultural restructuring & rural economy diversification
Economic growth: household affluence property market dynamics:
Labour market growth & specialization: expanding location choice
FACTORS IN DIRECT URBAN EXPANSION

Figure 8 Expansion factors of Periurban Area

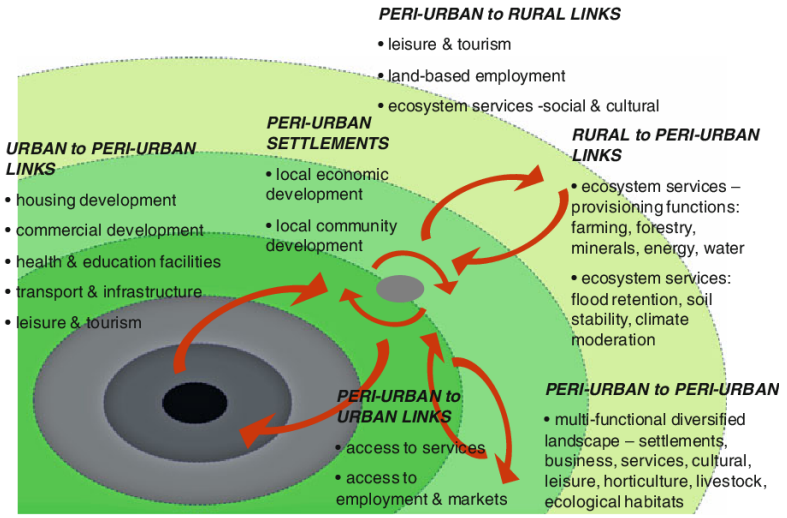

PERI-URBAN to RURAL LINKS
• leisure & tourism
• land-based employment
• ecosystem services -social & cultural
URBAN to PERI-URBAN LINKS
• housing development
• commercial development
• health & education facilities
• transport & infrastructure
• leisure & tourism
PERI-URBAN SETTLEMENTS
• local economic development
• local community development
RURAL to PERI-URBAN LINKS
• ecosystem services – provisioning functions: farming, forestry, minerals, energy, water
• ecosystem services: flood retention, soil stability, climate moderation
PERI-URBAN to URBAN LINKS
• access to services
• access to employment & markets
PERI-URBAN to PERI-URBAN
• multi-functional diversified landscape – settlements, business, services, cultural, leisure, horticulture, livestock, ecological habitats

Figure 9 Urban, Periurban and Rural linkages

2.3.4 Peri-Urban Transformation and Urban Expansion

Peri-urban zones undergo complex transformations driven by multiple factors:

- **Physical Change**: Includes land parcelling, conversion from agricultural to non-farm uses, infrastructure expansion, and population growth.
- **Economic Change**: Driven by the development of land markets, high land prices, and diversification of livelihoods.

- **Social and Institutional Change**: Refers to evolving tenure systems, family structures, and societal norms.

Urban expansion into peri-urban zones is often accompanied by shifting patterns of housing, employment, and infrastructure development. Diagrammatic representations in the reviewed literature also highlight the bidirectional flow of resources, people, and services between urban, peri-urban, and rural zones.

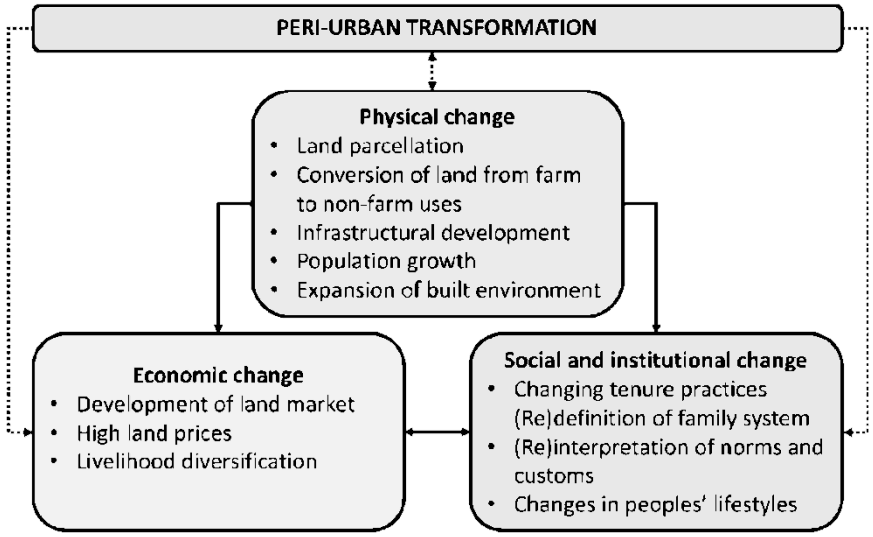


Figure 10 Periurban Transformation Factors

2.3.5 Settlement Patterns

Peri-urban areas contribute to the morphological evolution of cities, often manifesting in two broad forms:

- **Monocentric Settlement Patterns**: With a clear city center radiating into successive urban rings (suburban, fringe, periphery).
- **Polycentric Agglomeration Patterns**: Characterized by multiple urban nodes with interspersed peri-urban and rural areas, offering greater functional integration.

These patterns are critical in planning Wardha as a twin city to Nagpur, suggesting frameworks for balanced and integrated development.

This literature review lays the foundation for understanding the dynamic and multifaceted nature of peri-urban areas, which is essential in shaping a strategic spatial and functional integration plan for Wardha in alignment with Nagpur.

2.4 Case Study

Cities as engines of growth

Cities are regarded as the engines of economic growth, serving as hubs for innovation, industry, and trade that accelerate national development. However, efficient urban planning and management are crucial to realizing their true potential. Urban local bodies (ULBs) should aim for inclusive, sustainable growth and focus on enhancing the quality of life.

Recognizing the crucial role of urban areas in shaping *Viksit Bharat by 2047,* the Hon'ble Prime Minister emphasized during a post-budget webinar in 2023 that ***'… Urban planning will determine the fate of our cities in Amrit kaal and it is only well-planned cities that will determine the fate of India, …'.*** [26]

Growth Hub (G-Hub) initiative – A paradigm shift

The 'G-Hub Initiative' proposes a new approach for managing urbanization by going beyond urban boundaries to a regional approach, center-staging economic master planning and keeping sustainability and livability at the core of the process. It marks a pivotal step towards inclusive & sustainable development with a multisectoral approach, promoting cities as mega-growth hubs for the nation. Instead of a reactive approach toward managing urbanization, this initiative attempts to introduce a proactive approach with economic strategy as a precursor to the spatial planning.

Surat was one of the four pilot cities taken up by NITI Aayog under the G-Hub initiative for the preparation of the Economic Master Plan (EMP).

Inspired by the 5F vision of the Hon'ble Prime Minister- Farm to Fibre to Factory to Fashion to Foreign - Gujarat Industrial Development Corporation (GIDC) is developing the Mega Textile Park at Vansi, Navsari. This park is to be developed with assistance under the

PM MITRA a scheme of the Ministry of Textile, Government of India.[27] [26]

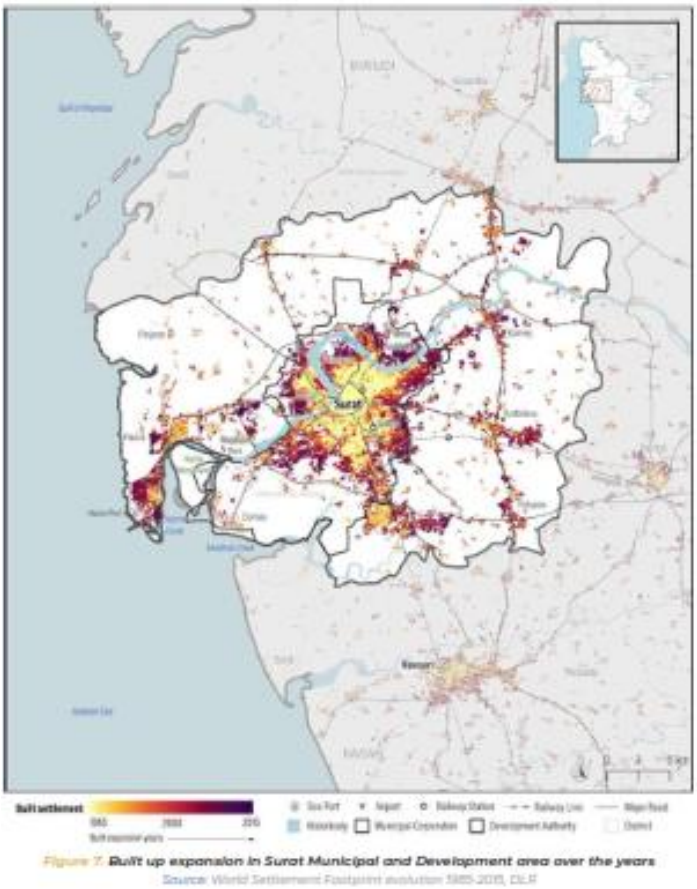


Figure 11 Expansion of Surat Urban Development Area

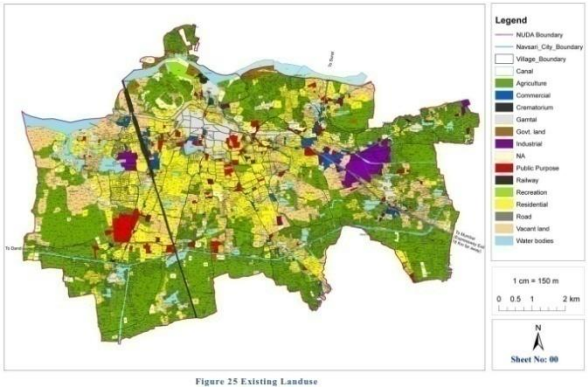


Figure 12 Existing Landuse Navsari Urban development area

With the announcement of formation of Navsari Urban Development Authority (NUDA), the concept of Surat and Navsari being future twin cities got a push. Furthermore, the state

Urban Development and Urban Housing Department has extended the limits of Surat Urban Development Authority (SUDA) from 722 sqkm to 1,332 sqkm by annexing 97 villages.
This is considered as the first concrete step towards establishing surat – navsari as a twin city by 2025 which would have an estimated population of 1.25cr. This area falls between surat and navsari from both the sides of state highway and national highway.

The authority of the local civic body and SUDA has started looking at the mega development of 60km area connecting surat and navsari. This sort of cluster development in residential and industrial sector is going to help achieve the goal of twin city sooner than expected as per SUDA officials.[28][29]

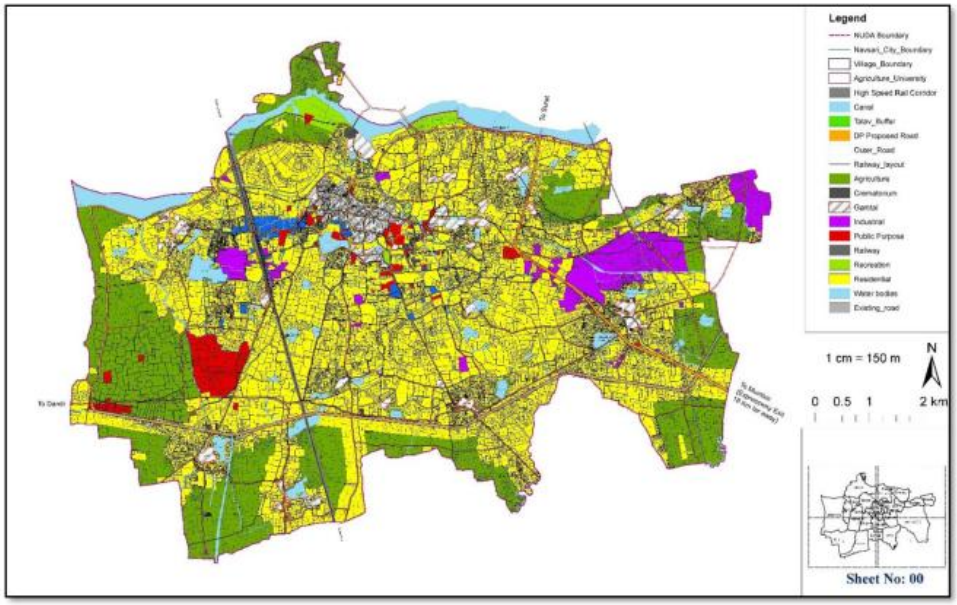


Figure 13 Prposed DP Plan Navsari urban development Area(NUDA)

Key Takeaways from Surat-Navsari Twin City Model

1. Strategic Planning under National Initiatives

- **G-Hub Initiative** by NITI Aayog: A proactive economic master planning strategy that goes beyond city limits, addressing regional development.
- Surat was selected as a **pilot city** under this scheme, emphasizing economic foresight as the core of spatial planning.

2. Institutional Framework and Governance

- **Extension of SUDA's jurisdiction** from 722 sq.km to 1,332 sq.km by annexing 97 villages.
- Formation of **Navsari Urban Development Authority (NUDA)** formalized the twin city approach.
- Empowerment of **local civic bodies** and development authorities to lead regional integration.

3. Infrastructure and Economic Development

- **Mega Textile Park** at Vansi (Navsari) under PM MITRA, aligns with PM's 5F vision (Farm → Fibre → Factory → Fashion → Foreign).
- Proposed **60 km development corridor** between Surat and Navsari to ensure continuous urban and industrial clusters.

4. Land Use Planning

- Maps show coordinated and complementary **land use patterns** between the two cities, fostering integrated development.
- Emphasis on **mixed-use and industrial zones**, improving employment access and reducing migration pressures on Surat.

Implications for Wardha–Nagpur Twin City Vision

We can be apply the Surat–Navsari model to Wardha–Nagpur using the following insights:

Surat–Navsari Model	Wardha–Nagpur Application Idea
G-Hub initiative focus on regional integration	Propose a similar **Growth Hub Zone** between Wardha–Nagpur
SUDA–NUDA creation and boundary extension	Recommend **Wardha Regional Planning Authority**
Economic cluster (e.g., Textile Park)	**Agro-industrial corridor** leveraging MIHAN and agritech in Wardha
60 km development link	Upgrade **NH-361 & railway** between Nagpur-Wardha with TOD nodes
Empowering local bodies (SUDA, NUDA)	Institutionalize **Wardha UDA**, aligned with NMRDA (Nagpur)
Coordinated land use planning	Propose **complementary land use zoning**, eg. logistics, education hubs in Wardha

Table 5 Key Takeover from Case study

2.5 Approach for Strategic Planning

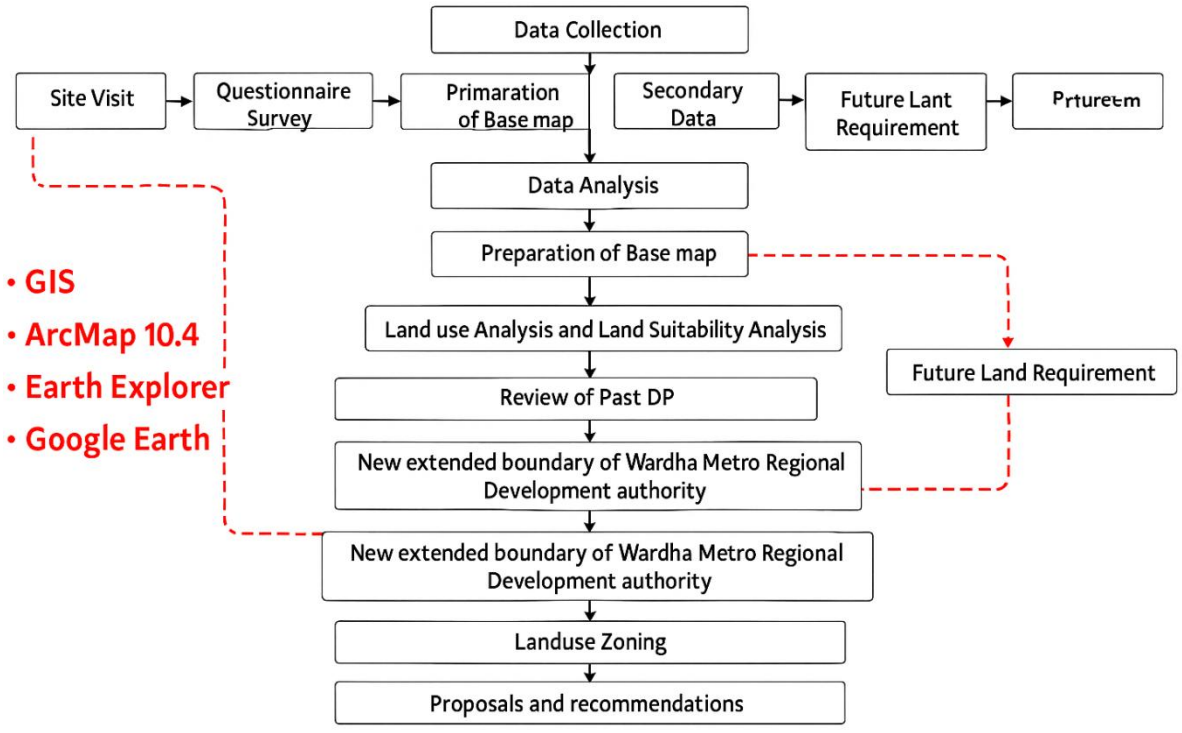


Figure 14 Approach Chart

1. Data Collection

- **Primary Sources**: Site visit, Questionnaire Survey
- **Secondary Sources**: Census data, Government Reports

2. Data Analysis

- Involves GIS and spatial tools like:
    - **ArcMap 10.4**
    - **Google Earth**
    - **Earth Explorer**

3. Preparation of Base Map

- Integrates both primary and secondary data for spatial analysis

4. Land Use & Suitability Analysis

- Based on current land characteristics and functional zoning

5. Review of Past Development Plans (DP)

6. Future Projection & Demand Analysis

- Informs **Future Land Requirement**

7. Define New Boundary

- For **Wardha Metro Regional Development Authority** (WMRDA)

8. Land Use Zoning

9. Proposals and Recommendations

- Final actionable outcomes for twin city planning

2.6 Tools and Models to be used for the Study

Tools Used for the thesis are GIS, ArcMap 10.4, ArcScene 10.4, Earth Explorer, GoogleEarth, TerrSet Software.

CHAPTER 3
PROJECT AREA

3.1 Project Area Overview

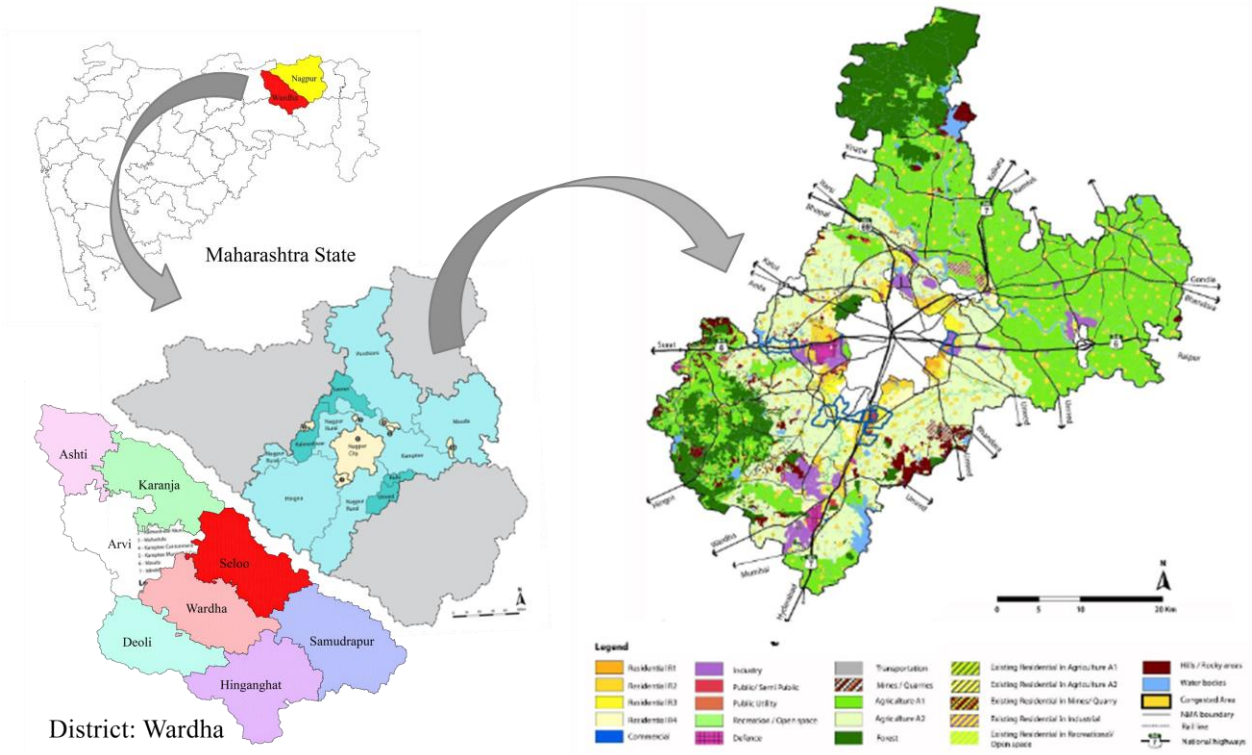


Figure 15 Project Area Overview

Location Context:

- Shows Wardha's position relative to Nagpur and within Maharashtra.
- Highlights Wardha and Seloo taluka as a focal point of analysis.
- Includes a detailed land use map with classifications like:
    - Residential (R1, R2)
    - Commercial
    - Industry
    - Green zones
    - Transportation networks
    - Mines/quarries

Sub-regional and Taluka Maps

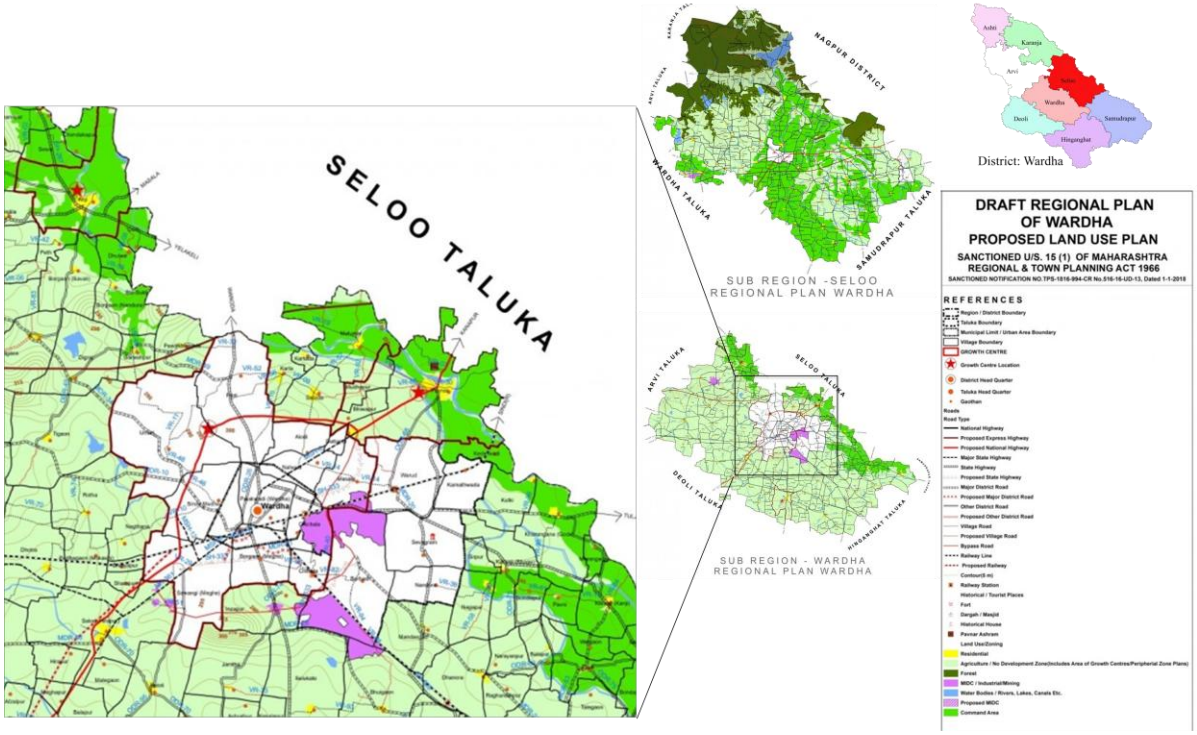


Figure 16 Wardha Region

Details:

- Shows Wardha Taluka and Wardha sub-region maps.
- Draft Regional Plan map with proposed land use.
- Reference legend for map interpretation, aligned with the Maharashtra Regional & Town Planning Act, 1966.

Metropolitan Fringe Area

Focus:

- Defined **Wardha Metropolitan Region** including fringe villages such as:
    - Pipri, Pawnar, Kedarwadi, Inzapur, Sawangi Meghe, etc.
- Refers to the **Urban Land Ceiling and Regulation Act 1976** for defining urban fringe:
    - Peripheral area up to 5 km around a city with a population of over 1 lakh.

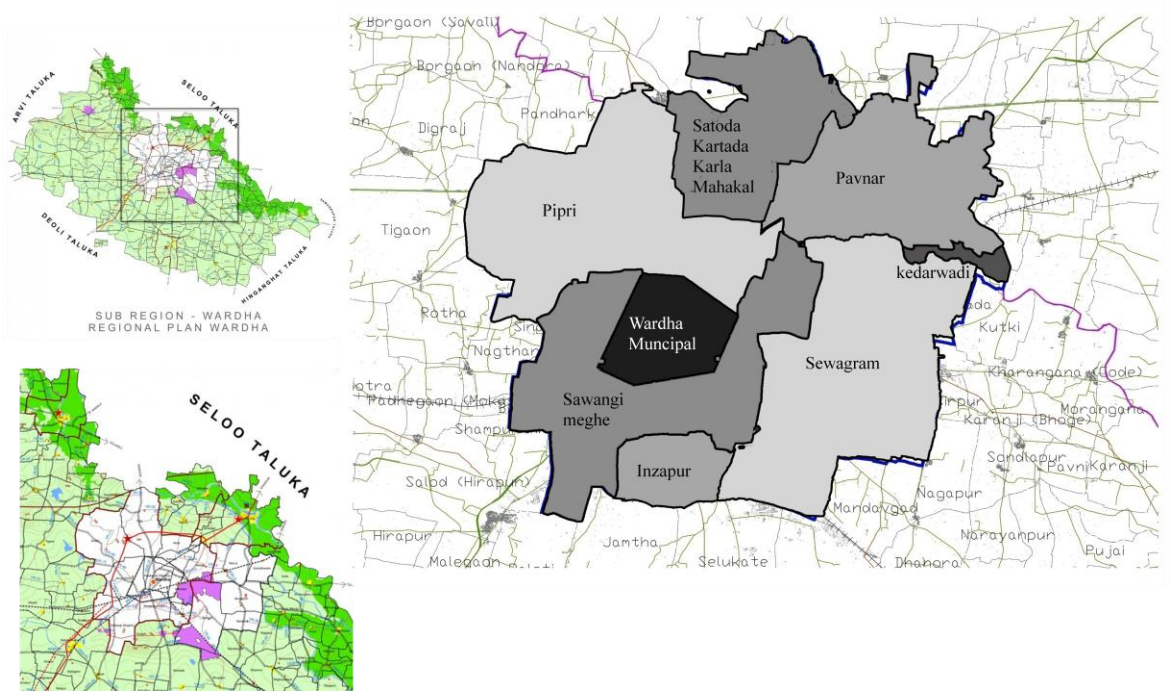


Figure 17 Wardha Metropolitan Region

3.2 Land Use and land cover Analysis of Existing Wardha Metropolitan Region

3.2.1 Introduction

The current land use pattern of Wardha serves as a foundational basis for envisioning its strategic integration with Nagpur. This analysis identifies key spatial patterns, development gaps, and opportunities for future land use planning to support the twin-city concept.

3.2.2 Existing Land Use Composition

As per the recent GIS-based mapping and 2025 land use data:

- **Agricultural Land (48.69%)**
  Dominates the landscape, indicating significant rural characteristics and potential land bank for urban expansion. Located predominantly on the city periphery, these

areas are vital for ensuring food security but also hold latent capacity for urban transition.

- **Residential Areas (25.62%)**

  Concentrated in the central and southern parts of the city. This indicates a compact urban core that may face pressure with projected population growth from **2.5 lakh in 2011 to 4.48 lakh by 2045**. Expansion or densification will be essential.

- **Industrial and Commercial Land**

  Industrial land is located mainly in the south and southwest zones, while commercial pockets are interspersed within the urban core. Limited spatial extent suggests a need for economic diversification to support a self-sustaining twin city.

- **Institutional Land**

  Educational and administrative institutions occupy limited but strategic zones. There is a need to plan new institutional corridors to attract investment and population from Nagpur.

- **Transport and Roads (4.93%)**

  Good connectivity exists along the east-west axis, with potential to be reinforced to enable regional integration with Nagpur, 75 km away.

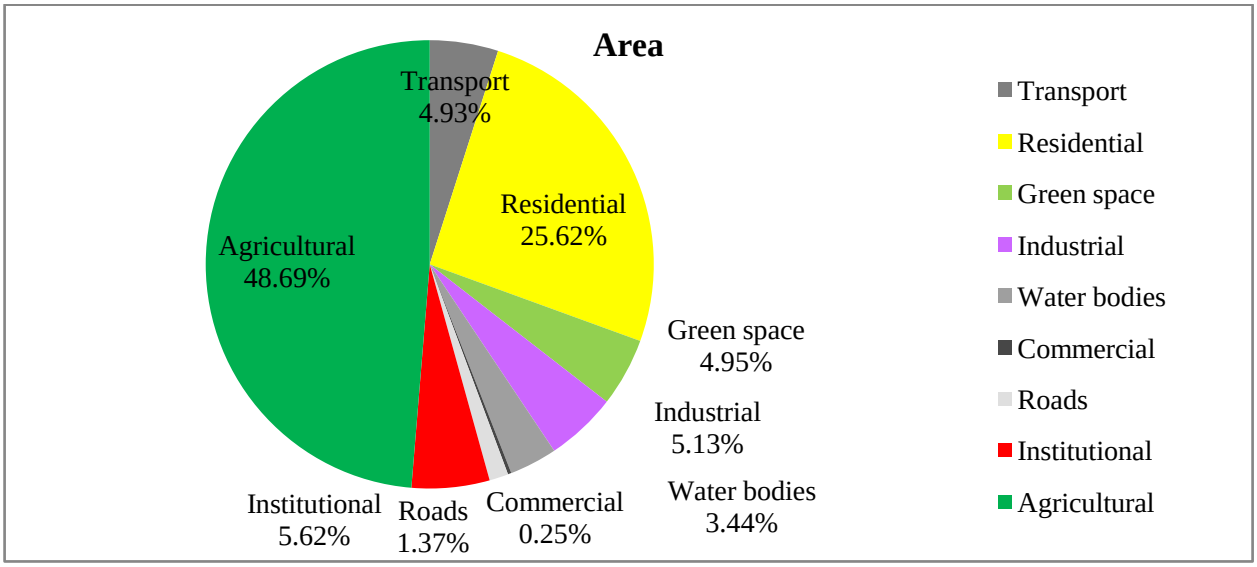


Figure 18 Landuse Percentage Pie chart

Land Use Type	Percentage
Agricultural	48.69%
Residential	25.62%
Transport	4.93%
Others (commercial, industrial, green, roads, etc.)	Remaining 20.76% (approximately)

Table 6 Landuse type and Percentage

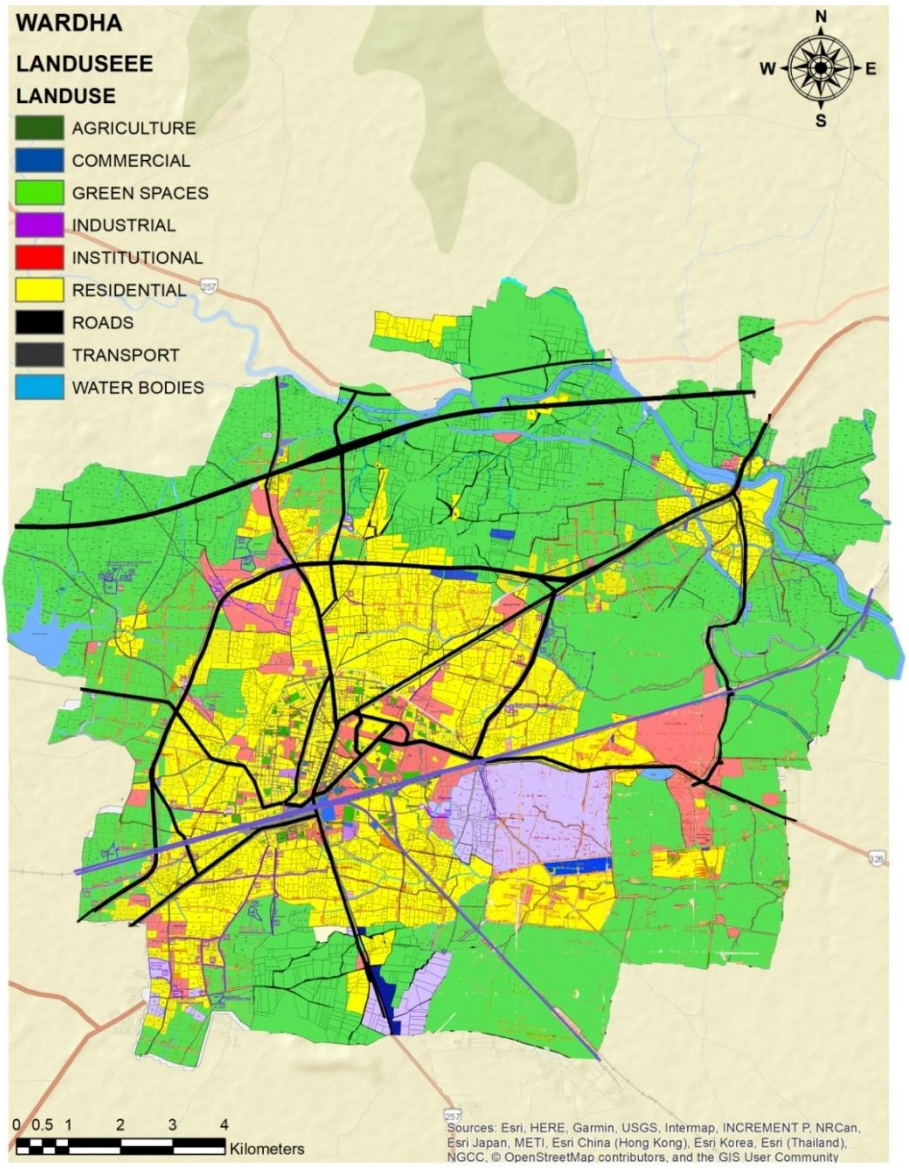


Figure 19 Land use Map Wardha Metrpolitan Region

Object_id	Value	Landuse	Classification	Percentage	Area
1	1	Transport		4.93	7.67
2	2	Residential		25.62	39.83
3	3	Green space		4.95	7.69
4	4	Industrial		5.13	7.97
5	5	Water bodies		3.44	5.35
6	6	Commercial		0.25	0.39
7	7	Roads		1.37	2.13
8	8	Institutional		5.61	8.73
9	9	Agricultural		48.69	75.70

Table 7 Land use Area and percentage

3.2.3 Strategic Implications for Twin-City Development

A. Urban Growth Zones

- The **agricultural zones along the southern and eastern fringe** can be re-designated as **urban growth corridors** with mixed-use planning and infrastructure provisioning.
- Prioritize **transit-oriented development (TOD)** along major roads to reduce car dependency and connect efficiently to Nagpur.

B. Integrated Economic Clusters

- Expand industrial areas along the southern belt, adjacent to existing employment zones.
- Promote **institutional and R&D clusters** (e.g., skill development centers, knowledge parks) on the northern fringe to attract young population and align with Nagpur's educational ecosystem.

C. Green Infrastructure

- Introduce **urban green belts** and buffer zones between residential and industrial uses.
- Protect and enhance **existing green and water bodies**, integrating them into urban design through eco-parks, stormwater channels, and recreational corridors.

D. Decentralized Planning

- To ease pressure from Nagpur, Wardha should develop **self-sufficient urban nodes** (sub-centers) with mixed land use including housing, markets, schools, and job centers.

3.2.4 Key Insights

Opportunities for Urban Expansion

- **Nearly 49% of land is still agricultural** — this indicates significant potential for controlled, sustainable urban expansion, especially if Wardha is to function as a **twin city** to Nagpur.
- **Potential areas for development:** South-eastern and north-western edges, where residential and transport corridors meet agricultural zones.

Residential Density Planning

- With 25.62% of land as residential, and population projected to rise from **2.5 lakh (2011)** to **4.48 lakh (2045)**, densification or rezoning may be needed to avoid sprawl.
- Integrated housing development could be planned near major transport corridors to **optimize connectivity with Nagpur**.

Industrial & Institutional Clusters

- Purple (industrial) and pink (institutional) areas are mainly in the southern and south-western regions.
- Future plans should prioritize **synergy between institutions and employment zones** for balanced development.

Environmental Considerations

- Despite limited green and water bodies, preserving these zones is vital as urbanization accelerates.
- A **green buffer strategy** could help mitigate heat islands and pollution.

3.2.5 Conclusion

The current land use structure of Wardha presents a balanced yet underutilized base for transformation. With nearly **half the metropolitan region as open land**, Wardha has the physical and spatial capacity to grow into a vibrant urban counterpart to Nagpur. Strategic rezoning, transit-integrated planning, and sustainable development principles can drive the successful implementation of the **twin-city model**, ensuring inclusive growth and regional balance.

3.3 Existing Land Use and Connectivity

The spatial structure of Wardha reveals a well-distributed mix of land uses supported by a multi-modal transport network, establishing a strong foundation for its transformation as a twin city to Nagpur. This section interprets existing land use in conjunction with regional connectivity to identify leverage points for future integration.

3.3.1 Land Use Classification

The base land use map displays five major categories:

- **Residential (Yellow):** Predominantly concentrated in the central and eastern zones, indicating urbanized development.
- **Public semipublic (Pink):** Clusters around key junctions and urban cores, reflecting economic activity zones.
- **Industrial (Purple):** Located in the southern and southeastern zones, notably around MIDC and near railway corridors.

- **Commercial (Blue):** Strategically positioned near residential areas to ensure accessibility to essential services.
- **Agricultural & Open Land (Green):** Vast peripheral zones dominated by agriculture, highlighting rural land use continuity.

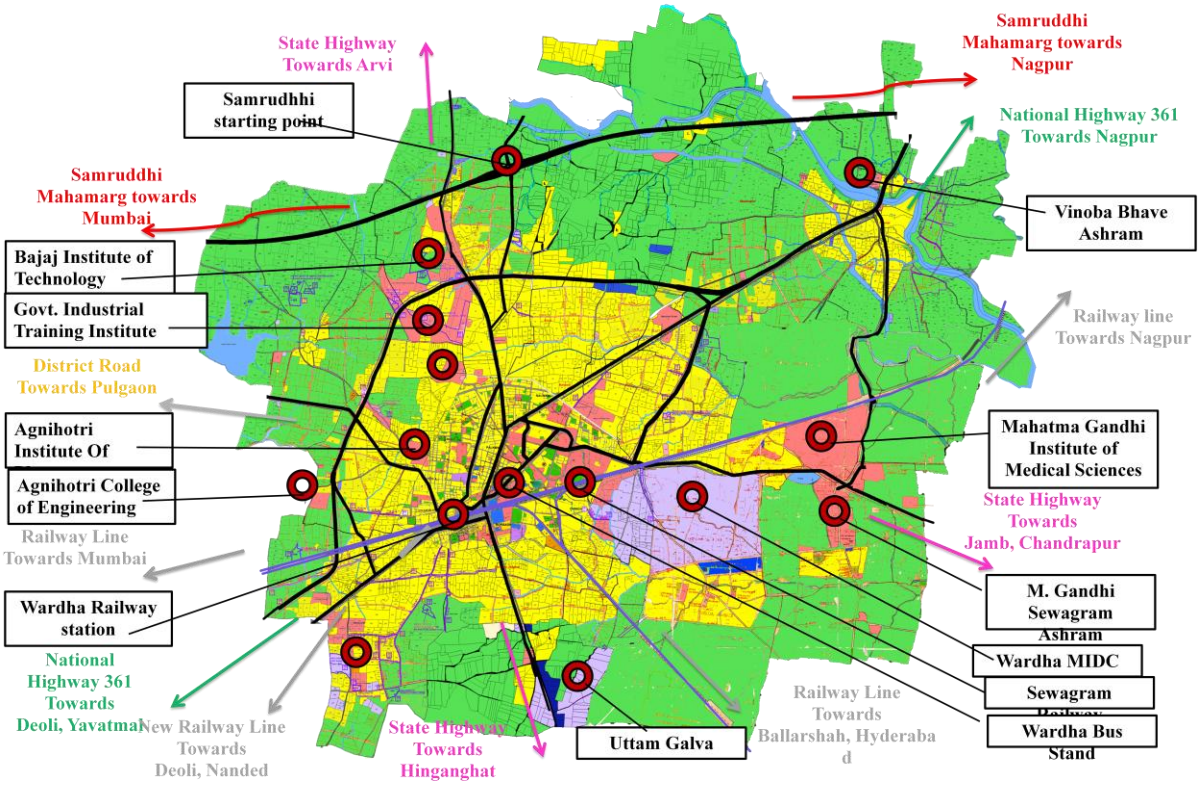


Figure 20 Existing Landuse with Connectivity and Major Institutions

This spatial layout illustrates a **centralized urban core with radial expansion**, where urban sprawl is guided along transport corridors.

3.3.2 Key Connectivity Infrastructure

Wardha is endowed with a robust transport network that supports both **regional linkages** and **intra-city mobility**:

- **Highways:**
  - **Samruddhi Mahamarg:** Offers high-speed connectivity to Nagpur (east) and Mumbai (west), fostering regional economic synergy.

    - **National Highway 361:** Acts as a spine, linking Nagpur with Deoli and Yavatmal, running diagonally through the city.
    - **State Highways:** Extend towards Arvi, Hinganghat, Jamb, and Chandrapur, enhancing rural-urban integration and decentralization.
- **Railways:**
    - Wardha is a **rail hub**, linked in multiple directions:
        - **West:** Mumbai
        - **North-East:** Nagpur
        - **South-West:** Deoli, Nanded (via new alignment)
        - **South-East:** Ballarshah and Hyderabad
    - The railway network improves **regional accessibility** and supports **freight movement**, especially for industrial growth.
- **District Roads:**
    - Linkages to Pulgaon and other hinterland settlements play a pivotal role in supporting local logistics and agricultural connectivity.

3.3.3 Strategic Implications

This existing layout positions Wardha as a **regional mobility node**, critical for:

- **Economic decentralization** from Nagpur
- Facilitating **commuter movement** and industrial freight
- Integrating urban and rural economies
- Planning **Transit-Oriented Development (TOD)** around rail and highway junctions

Thus, the synergistic alignment of land use and transportation infrastructure strengthens Wardha's candidacy as a functional and spatial counterpart to Nagpur.

CHAPTER 4
PROJECTION

4.1 Projected Population Scenarios of Wardha (2025 –2045)

4.1.1 Population of Wardha Metropolitan Region

Name	Area in sq.m.	Population								
		1991			2001			2011		
		Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Wardha District	6310 km²	10,67,357	7,83,840	2,83,517	12,36,736	9,11,695	3,25,041	13,00,774	8,77,474	4,23,300
Wardha Tehsil	774.4 km²	2,46,303	147216	99087	3,14,808	1,88,136	1,26,672	3,57,476	1,44,874	2,12,602
Wardha Metropolitan Region	155.46 km²	171511	45429	126082	202790	30494	172296	2,50,697	38,095	2,12,602

Table 8 Existing Population

Area and Population (2011):

- **Wardha District:**
  - Area: 6310 km²
  - Total Population: 13,00,774 (Urban: 4,23,300; Rural: 8,77,474)[30]
- **Wardha Tehsil:**
  - Area: 774.4 km²
  - Population: 3,57,476 (Urban: 2,12,602; Rural: 1,44,874)[30]
- **Delineated Wardha Region:**
  - Area: 155.46 km²
  - Population: 2,50,697 (Urban: 2,12,602; Rural: 38,095)[30]

Number and percentage of scheduled castes and scheduled tribes population in towns, 2011				
Sr.No.	Name of town	Total Population	Total scheduled castes population	Total scheduled tribes population
1	802696-Wardha (M Cl)	106444	16386	5830
2	534191-Pipri (CT)	23661	2176	1768
3	534192-Sindi Turf Hindnagar (CT)	20956	6168	985

4	534193-Warud (CT)	6386	1439	308
5	534194-Masala (CT)	8883	2247	625
6	534195-Nalwadi (CT)	12119	2413	1241
7	534196-Borgaon (Meghe) (CT)	19759	3122	985
8	534197-Sawangi (Meghe) (CT)	14394	5721	620
	(Urban) Wardha Tehsil	212602	39672	12362

Table 9 Census Town Population within Wardha Metropolitan Area

Scheduled Caste (SC) & Scheduled Tribe (ST) Population in Urban Wardha Tehsil (2011):

- **Total Urban Population:** 2,12,602
- **SC Population:** 39,672 (~18.7%)
- **ST Population:** 12,362 (~5.8%)

Name Village	**Total Population (2011 Census)**
Pavnar	7752
Kedarwadi	0
Kamathwada	200
Satoda	1608
Alodi	5588
Umari	3469
Palakwadi (Wardha)	0
Bhaiyapur	0
Chitoda	1184
Karla	1158
Kartada	0
Mahakal	2048
Mudhapur	0
Barbadi	4898
Sevagram	6679
Inzapur	2110
Total Rural	**38095**

Table 10 Village Population with in Wardha Metropolitan area

Largest Urban Centres:

1. Wardha (M CI) – 1,06,444 population
2. Pipri (CT) – 23,661
3. Sindi Turf Hindnagar (CT) – 20,956[30]

Rural Villages with Notable Populations:

- Pavnar (7,752), Sevagram (6,679), Alodi (5,588), Barbadi (4,898), Umari (3,469)[30]

4.1.2 Population Projection up to 2045

Name	Area in sq.m.			POPULATION PROJECTION UPTO 2045				
		1991	2001	2011	2021	2025	2035	2045
		Total	Total	Total	Total	Total	Total	Total
Wardha District	6310 km²	1067357	1236736	13,00,774	1424208	1427997	1486006	1514208
Wardha Tehsil	774.4 km²	246303	314808	3,57,476	4,10,684	4,31963	479704	525753
Wardha Metropolitan Region	155.46 km²	171511	202790	2,50,697	296834	321949	380452	448004

Table 11 Population projection

Growth Trends (Total Population):

- **Wardha District:**
  - 1991: 10.67 lakh → 2045: 15.14 lakh
- **Wardha Tehsil:**
  - 1991: 2.46 lakh → 2045: 5.26 lakh
- **Delineated Wardha Urban:**
  - 1991: 1.71 lakh → 2045: 4.48 lakh

Projected Urban Growth (Wardha Urban):

- 2011: 2,50,697
- 2025: 3,21,949
- 2035: 3,80,452
- 2045: 4,48,004

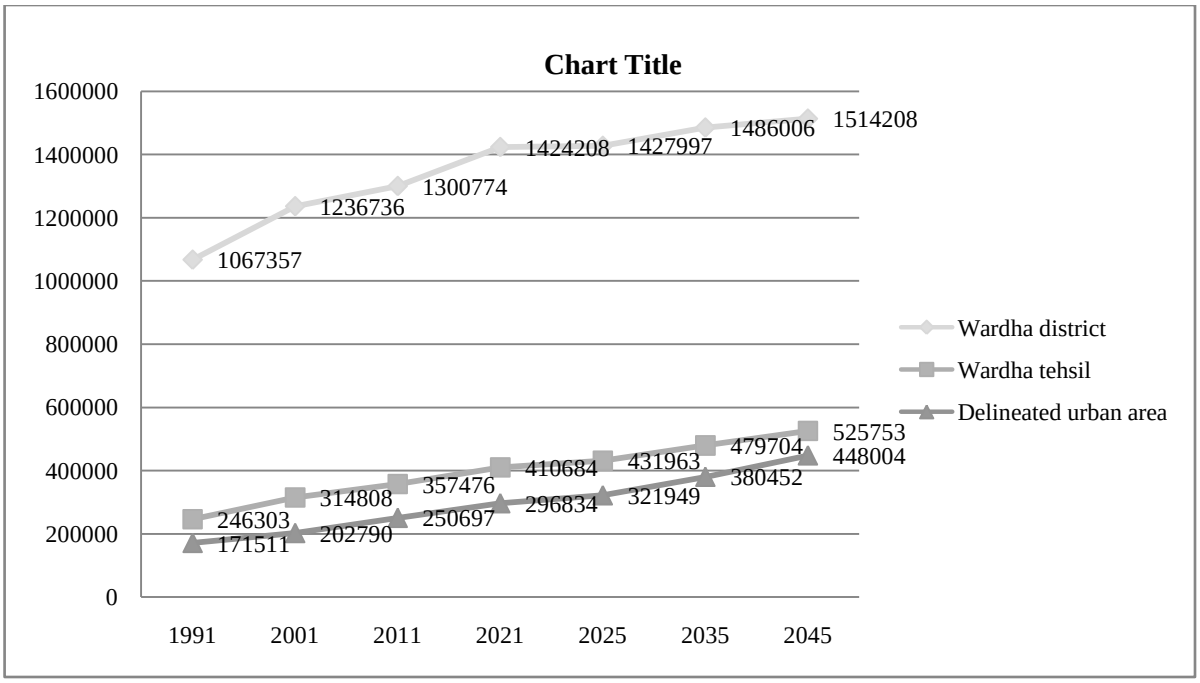


Table 12 Population projection Chart

Observation:

Wardha's urban population is projected to **nearly double** from 2011 to 2045, indicating increasing urbanization and potentially higher demand for housing, infrastructure, and transport—supporting the case for **spatial and functional integration** with Nagpur.

4.2 Projected Land Use Scenarios for Wardha (2025–2045)

4.2.1 Methodology

The projection is based on:

- **Population growth trends** (2011–2045)
- **Urban development norms** (e.g., URDPFI guidelines)
- **Per capita land use requirements** (residential, commercial, etc.)
- **Land use suitability and constraints** (from existing map)
- **Scenario-based urban growth modeling**

4.2.2 Population Projections

From above data:

- **2011:** 2.50 lakh
- **2025:** 3.22 lakh
- **2045:** 4.48 lakh

Urban area growth from 155.46 km² in 2011 will need to be revised upward to accommodate the increasing population while ensuring space for economic and institutional infrastructure.

4.2.3 Per Capita Land Use Requirements (Urban Planning Norms)

Based on URDPFI Guidelines (MoHUA), typical per capita land requirements are:

Land Use Category	**Area per capita (sq.m)**	**2025 Demand (ha)**	**2045 Demand (ha)**
Residential	25	805	1,120
Commercial	4	129	179
Industrial	5	161	224
Recreational/Green	10	322	448
Institutional	10	322	448
Transport (roads, terminals)	20	645	896
Total	**74**	**2,384 ha**	**3,315 ha**

Table 13 Area Requirement as per Population Projection

1 hectare = 10,000 sq.m
3,315 ha = 33.15 sq.km (by 2045)

So by **2045**, Wardha urban will require **33.15 sq.km additional urban land** beyond current urbanized zones to meet projected needs.

4.2.4 Proposed Land Use Distribution: 2045

Land Use	% of Developed Area	Area (sq.km)
Residential	33–35%	~15.0
Commercial	5–7%	~2.0
Industrial	8–10%	~3.0
Green/Open Space	10–12%	~4.0
Institutional	8–10%	~3.0
Roads & Transport	20–22%	~7.0
Total (Urban)	—	~44.0

Table 14 Required Landuse Area

This increase accounts for densification and new development. Additional ~11 sq.km from current 33 sq.km urban use is required to be planned in **urban growth zones** identified on the land use map.

4.2.5 Strategic Growth Zones (Spatial Recommendations)

North-East Expansion Zone:
Well-connected to Samruddhi and National Highway, ideal for a **logistics and transport corridor**.

North-West Institutional Cluster:
Proximity to green spaces and existing transport routes makes it suitable for **universities, research parks, and hospitals**.

East Residential and Mixed-use Corridor:
Well-connected to city core and surrounded by agricultural land, suitable for **affordable and mid-income housing**.

Southern Expansion Zone:
Adjacent to existing industrial and agricultural land, ideal for a **SEZ and industrial corridor**.

CHAPTER 5
MAJOR ANALYSIS

5.1 Future Land Use Suitability Analysis

The identification of optimal areas for future urban development is a critical component of sustainable urban planning, especially when preparing a strategic vision for integrating Wardha as a functional twin city to Nagpur. This section presents the findings of a comprehensive **Land Use Suitability Analysis**, conducted using a GIS-based **Weighted Overlay Model**, to delineate zones with varying degrees of suitability for urban expansion.

5.1.1 Methodology

The analysis employed six key indicators; each assigned a weight based on its relevance to urban development. The indicators included: **Slope (10%)**, **Proximity to Major Roads (20%)**, **Land Use Type (36%)**, **Proximity to Water Bodies (10%)**, **Normalized Difference Vegetation Index – NDVI (14%)**, and **Aspect (10%)**. Each factor was reclassified into five suitability classes (1–5), ranging from "Not Suitable" to "Most Suitable."

A weighted overlay was performed in ArcGIS, with the resulting composite suitability map categorizing the land into five suitability classes. These classes were color-coded for clarity:

- **Class 1 (Red)** – Not Suitable
- **Class 2 (Orange)** – Least Suitable
- **Class 3 (Yellow)** – Moderately Suitable
- **Class 4 (Light Green)** – Suitable
- **Class 5 (Dark Green)** – Most Suitable

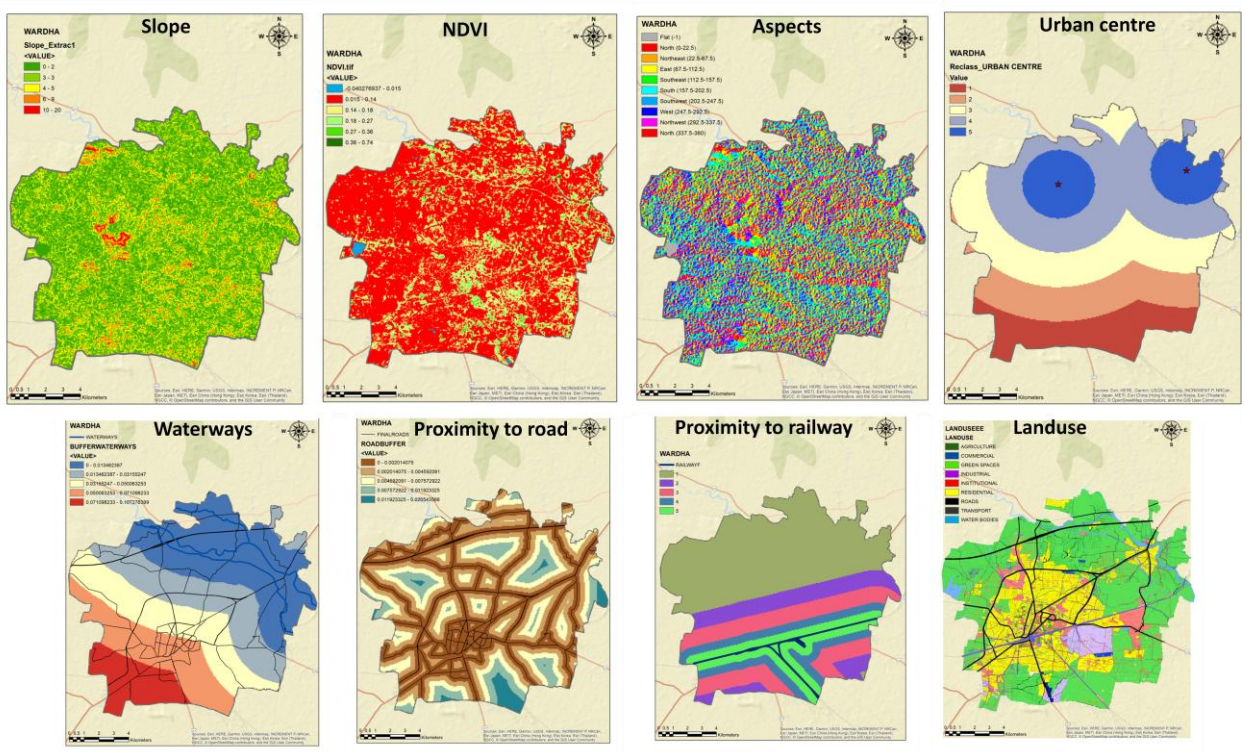


Figure 21 Spatial maps

Category	Indicator	Weight	Description
Slope	Slope of the land	0.10	Land with gentle slopes is more suitable for urban development than steep areas.
Proximity to Transport Networks	Distance to roads, railways, and public transport	0.20	Accessibility to transport networks like roads and rail is essential for development.
Land Use	Current zoning and land use regulations	0.36	Land zoned for residential or commercial use is more suitable than agricultural or protected areas.
Water ways	Access to water sources (e.g., rivers, lakes, groundwater)	0.10	Proximity to reliable water sources is vital for urban areas.
NDVI	Vegetation	0.14	Barren land, water, wetland, b/up, shrubs, grassland and dense vegetation
Aspects	Direction	0.10	Direction for better development and growth

Table 15 Category with Weight for Urban Expansion

5.1.2 Projected Future Land Use Scenarios (Interpretation)

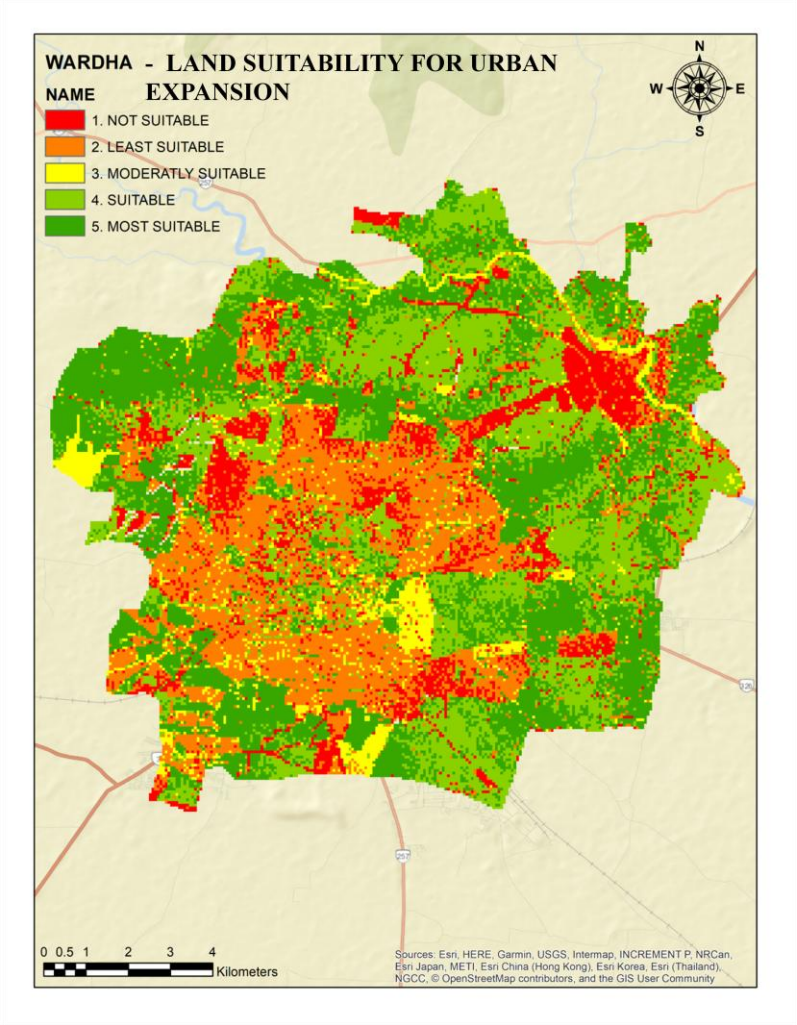

WARDHA - LAND SUITABILITY FOR URBAN EXPANSION
NAME
1. NOT SUITABLE
2. LEAST SUITABLE
3. MODERATLY SUITABLE
4. SUITABLE
5. MOST SUITABLE
N
W
E
S
0 0.5 1 2 3 4
Kilometers
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Figure 22 Land suitability Map for Urban Expansion

Object id	Value	Site_suitability	Classification	Percentage	Area
1	1	Not suitable	1	21.16	32.90
2	2	Least suitable	2	16.68	25.94
3	3	Moderate suitable	3	6.37	9.91
4	4	Suitable	4	34.90	54.26
5	5	Most suitable	5	20.88	32.45

Table 16 Area and percentage of Suitable urban expansion land after classification

5.2 Land Suitability Indicators and Analysis for Transport Expansion

To strategically identify optimal locations for transport hub expansion in Wardha as part of its functional integration with Nagpur, a comprehensive **Land Suitability Analysis (LSA)** was conducted. The analysis utilized a **weighted overlay technique in GIS**, integrating multiple spatial indicators to evaluate the development potential of land parcels.

5.2.1 Methodology:

The process involved several systematic steps:

1. **Identification of Influential Factors:** Key spatial indicators affecting transport infrastructure suitability were selected. These included:
    - Proximity to major roads (weight: 0.25)
    - Proximity to railways (weight: 0.20)
    - Existing land use (weight: 0.15)
    - Slope (weight: 0.10)
    - Proximity to urban centers (weight: 0.10)
    - NDVI - Vegetation index (weight: 0.14)
    - Flood zones (weight: 0.10)
2. **Data Preparation:** Relevant spatial datasets for each factor were collected, cleaned, and standardized for GIS processing.
3. **Weight Assignment:** Each indicator was assigned a weight based on its relative influence on transport hub viability, ensuring the most critical factors (e.g., connectivity) had a stronger impact on the final score.
4. **Reclassification and Overlay:** All layers were reclassified on a 5-point suitability scale (1 = least suitable, 5 = most suitable), and then overlaid using GIS to produce a composite suitability score.

5. **Suitability Map Generation:** The final output was a **land suitability map**, visually representing areas ranging from least (red) to most suitable (green) for transport infrastructure development.

Indicator	Weight (%)	Description
Proximity to Major Roads	**25**	Ensures accessibility and connectivity to the transport network.
Proximity to Railways	**20**	Facilitates multimodal transport integration.
Land Use Compatibility	**15**	Avoids conflicts with existing land uses and leverages suitable zones.
Topography (Slope)	**10**	Prefers flat terrains for construction and operation efficiency.
Proximity to Urban Centers	**10**	Enhances accessibility for users and integration with urban infrastructure.
Environmental Constraints	**10**	Considers protected areas, flood zones, and other environmental factors.
NDVI Suitability Scale for Transport Hub Site Selection	**10**	For transport hubs, **low vegetation or barren areas are more suitable**.

Table 17 Category with Weight for Transport Expansion

Grading System:

Each land parcel was graded based on the following criteria:

- **1: Not suitable** – Conditions are highly unfavorable.
- **2: Least suitable** – Marginal potential with considerable constraints.
- **3: Moderately suitable** – Fair potential; requires moderate intervention.
- **4: Suitable** – Good potential with minor adjustments.
- **5: Most suitable** – Optimal for immediate development.

5.2.2 Insights from the Suitability Map:

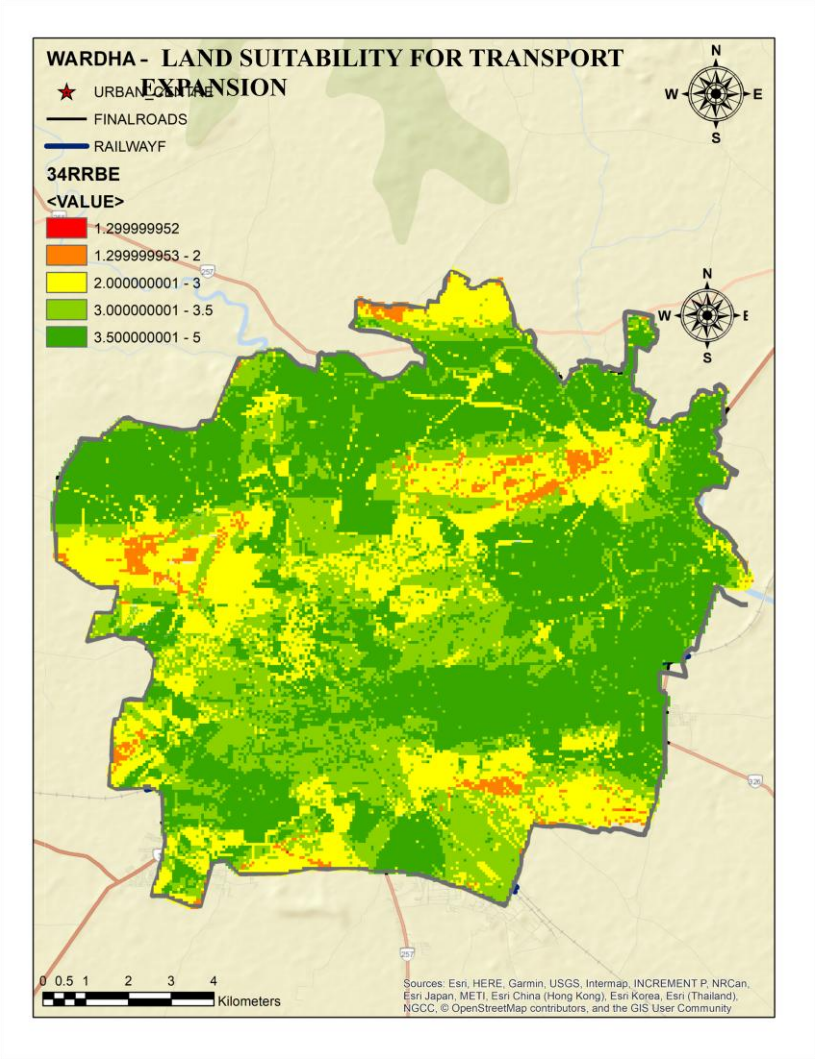


Table 18Land suitability Map for Transport Expansion

Object_id	Value	Site_suitability	Classification	Percentage	Area
1	1	Not suitable	1	0.01	0.01
2	2	Least suitable	2	2.37	3.69
3	3	Moderate suitable	3	23.70	36.84
4	4	Suitable	4	26.77	41.62
5	5	Most suitable	5	47.15	73.30

Table 19 Area and percentage of Suitable Transport expansion land after classification

This suitability analysis is crucial for guiding **evidence-based decision-making** in identifying potential sites for transport hubs that can serve as catalysts for Wardha's development as a complementary twin city to Nagpur.

Most Suitable Areas (Class 5 - Dark Green):

- **Concentrated mostly in the northwest and central regions** of Wardha.
- These are flat, accessible (close to main roads), already built-up or open areas, and at a safe distance from waterways.
- **Proposed Use**: Residential expansion, mixed-use townships, institutional zones, or IT/industrial parks.

Moderately to Suitable Areas (Class 3–4 - Yellow/Light Green):

- Found scattered around the urban periphery.
- May require basic infrastructure extension (roads, drainage).
- **Proposed Use**: Buffer zones for transition land uses like warehousing, logistics, light industries, or affordable housing clusters.

Least to Not Suitable Areas (Class 1–2 - Red/Orange):

- Mostly located in the southern and eastern zones.
- Steeper slopes, closer to water bodies, heavily vegetated, or agriculturally active.
- **Proposed Use**: Conservation areas, green belts, restricted/agricultural zones, or eco-tourism.

5.2.3 Strategic Implications for Wardha–Nagpur Twin City Development

Urban Growth Direction:

- Encourage **northwestern and central Wardha** as the primary urban growth corridor.

- Integrate road and transit enhancements to link these zones with Nagpur more efficiently.

Transport Integration:

- Align high-suitability zones with planned **mass transit** (e.g., BRTS, rail nodes) to promote Transit-Oriented Development (TOD).
- **Central and southeastern zones** of Wardha show **high suitability**, attributed to good road and rail connectivity and low-risk physical features.

Conservation & Risk Mitigation:

- **Western and far northern areas** are less suitable due to unfavorable topography, poor connectivity, or environmental constraints.
- Restrict urban expansion in **red zones**, near river buffers and high-slope regions.
- Integrate green infrastructure (urban forests, parks) within unsuitable lands.

Mixed-Use & Affordable Housing:

- Utilize moderately suitable lands (yellow/light green) for mid-density housing with supporting amenities.

5.2.4 Conclusion

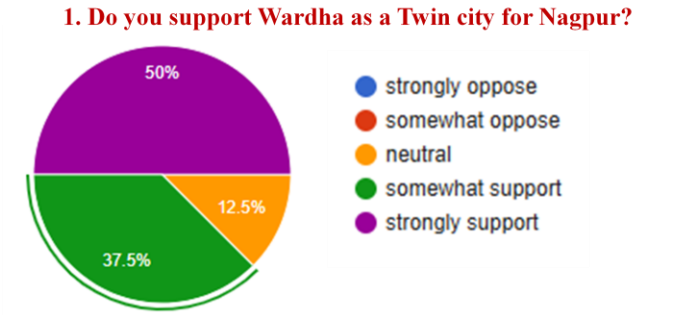
The suitability model offers a scientifically grounded tool for guiding urban expansion, infrastructure planning, and policy interventions. When integrated with socio-economic trends and participatory planning, it can drive Wardha's transformation into a resilient, inclusive, and complementary twin city to Nagpur. The next section will correlate these spatial findings with demographic projections and public perception data to formulate holistic land use strategies.

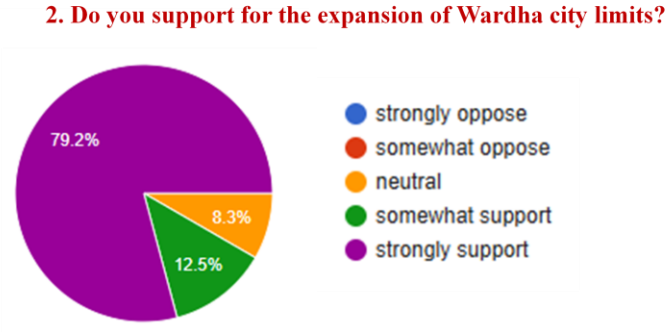
CHAPTER 6
SURVEY ANALYSIS

Overview

This chapter presents an analytical summary of a structured public survey conducted to evaluate the viability, public sentiment, and developmental priorities for spatial and functional integration of Wardha as a twin city to Nagpur. The findings reveal a robust mandate for integration, improved connectivity, balanced industrial development, and sustainable urban planning.

6.1 Public Sentiment and Support





Support for Twin City Concept (Q1)

- **87.5%** of respondents either strongly support or somewhat support the idea of developing Wardha as a twin city to Nagpur.

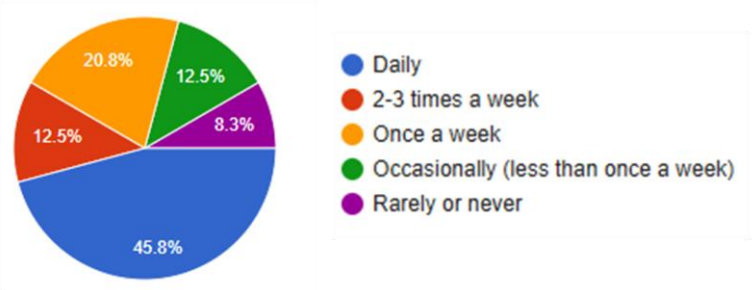
- This strong backing underscores a high level of **public endorsement for regional integration**.

Support for City Expansion (Q2)

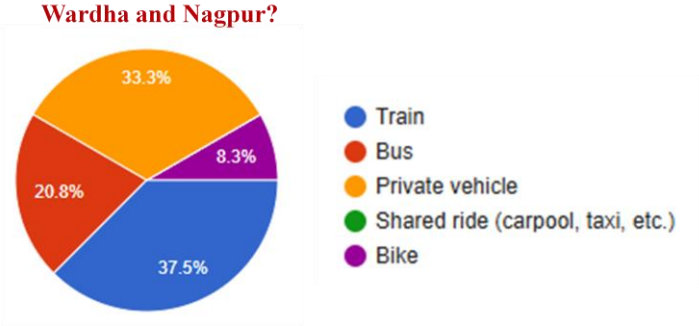
- A notable **92%** support the expansion of Wardha's city limits.
- Reflects readiness for **urban transformation** and **spatial growth**, crucial for twin city functionality.

6.2 Travel Behavior and Preferences

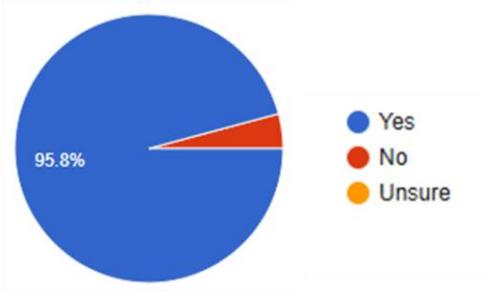
3. How often do you travel between Wardha and Nagpur?



4. What is your primary mode of transportation between Wardha and Nagpur?



5. Would you prefer a metro or light rail system connecting Wardha to Nagpur?



Travel Frequency (Q3)

- **45.8%** of participants travel occasionally between Wardha and Nagpur, while only **8.3% commute daily**.
- Indicates **latent demand** for better and more frequent transportation options.

Mode of Transport (Q4)

- Primary modes include **Train (37.5%)** and **Private Vehicles (20.8%)**.
- **Low reliance on buses (8.3%)** points to a gap in efficient public transport options.

Preferred System (Q5)

- A significant **95.8% favor metro/light rail** connectivity between the cities.
- Suggests clear public support for **high-capacity, rapid mass transit systems (RMTS)**.

6.3 Transport Needs and Infrastructure Gaps

Desired Improvements (Q6)

- **Frequent public transport (87.5%)**, **Improved railways (75%)**, and **Better road connectivity (54.2%)** are top priorities.
- Indicates demand for **integrated multi-modal transport systems**.

Influencing Factors (Q7)

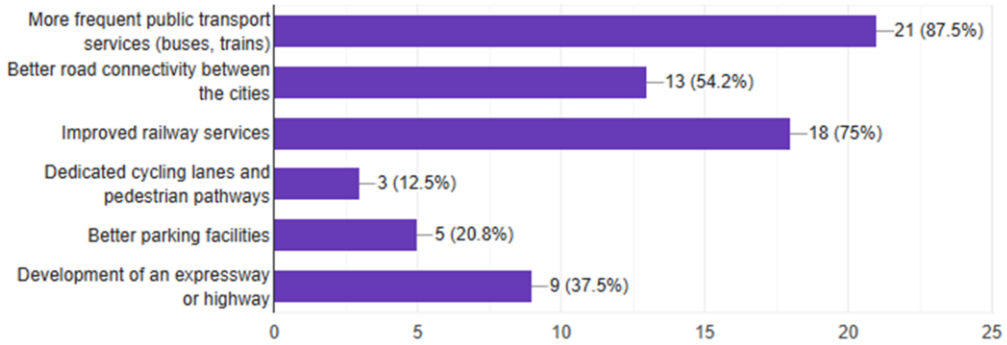
- **Time (79.2%)** and **Cost (66.7%)** are key decision drivers in travel mode choice.
- Highlights the importance of **affordable and efficient** commuting options.

Urban Infrastructure Needs (Q8)

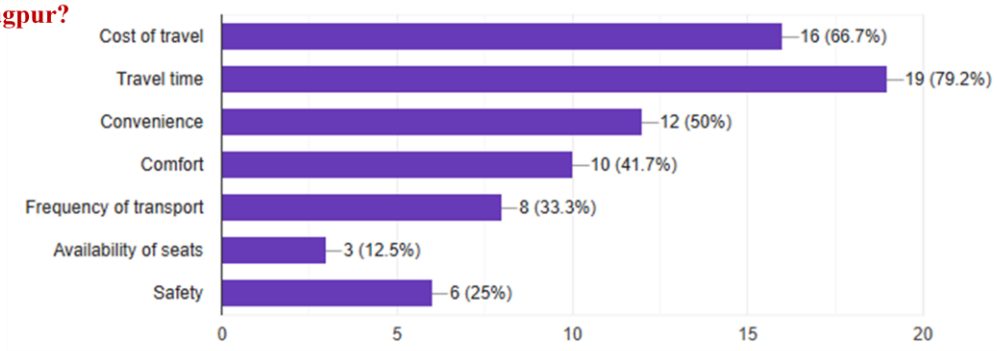
- Top needs include **Public Transport (83.3%)** and **Roads/Highways (75%)**.

- **Green spaces and parks** also emerged as a preference, indicating a desire for **sustainable urban environments**.

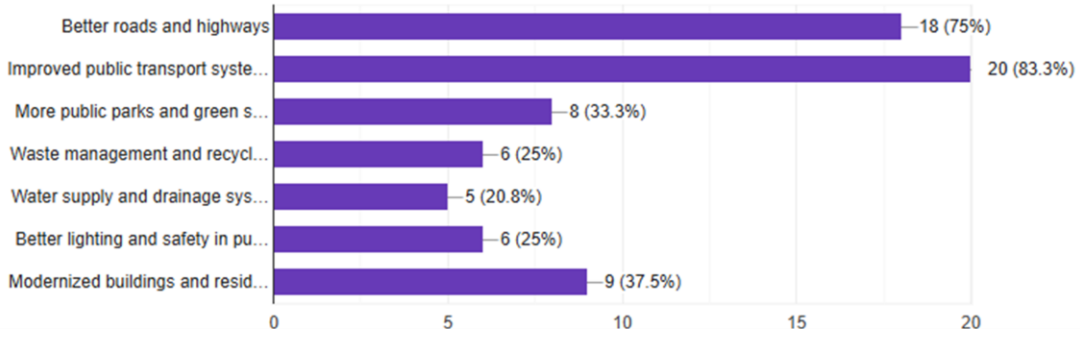
6. What improvements in transportation would make commuting between Wardha and Nagpur easier for you?



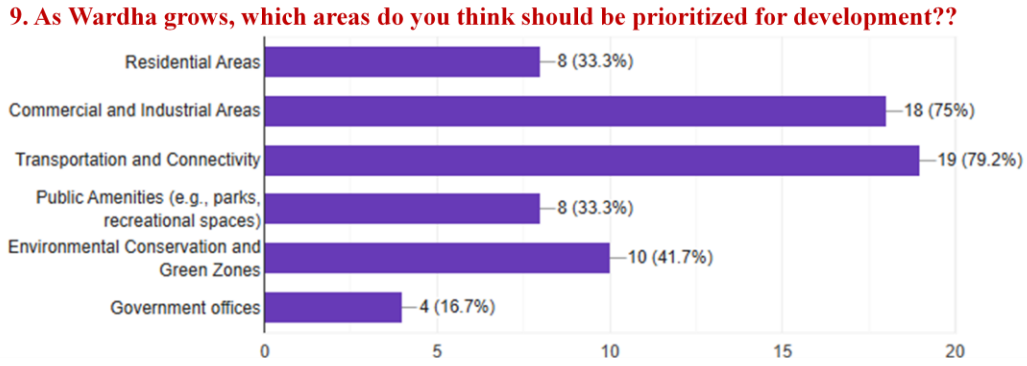
7. What factors influence your choice of transportation between Wardha and Nagpur?



8. What kind of physical infrastructure improvements would you like to see in Wardha to improve its urban development?



6.4 Urban Development Priorities



Preferred Development Zones (Q9)

- **Transport and Connectivity (79.2%)** and **Commercial & Industrial Areas (75%)** ranked highest.
- Demand for **public amenities, green zones**, and **environmental conservation** suggests strong public interest in **inclusive and livable urban planning**.

6.5 Industry and Economic Development

Preferred Industries in Wardha (Q10)

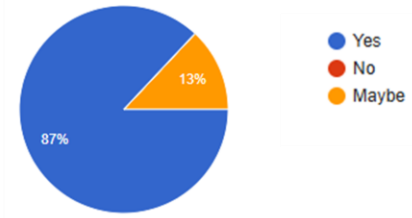
- **Manufacturing (45.8%)** and **Agro-based industries (16.7%)** dominate public preference.
- **Renewable energy** and **service sectors** follow, suggesting **diversified industrial interest**.

Textile Industry Expansion (Q11)

- **87% support reviving the textile industry**, highlighting cultural-economic potential for **heritage-based growth**.

10. What type of industries would you like to see expand or establish new facilities in Wardha?

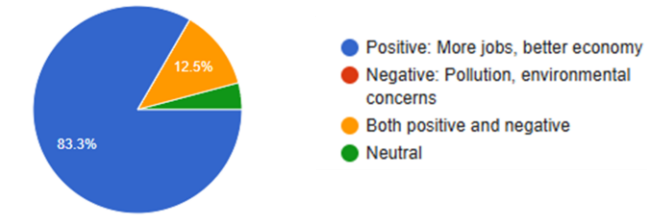
11. Wardha has a rich agricultural and textile history. Do you think there should be a focus on expanding the textile industry in the region?



12. What industries would you like to see prioritized in a potential SEZ in Wardha?

13. What potential impacts do you foresee with the development of a logistics park in Wardha?

14. How do you think the growth of industry in Wardha will affect the local community?



Industries in SEZ (Q12)

- Top sectors include **Textile & Garment (58.3%)**, **Pharmaceuticals/Healthcare**, and **IT**.

- Reflects a **balanced economic vision** mixing legacy and emerging industries.

Logistics Park Impact (Q13)

- **83.3% foresee positive economic impacts**, mainly through job creation and business stimulation.
- **12.5% raise environmental concerns**, emphasizing the need for **eco-conscious development**.

Community Impact from Industry (Q14)

- **83.3% expect benefits such as employment and economic growth**.
- Minor environmental and pollution-related concerns persist.

6.6 Key Insights and Planning Implications

Strong Public Mandate

- Overwhelming support for Wardha-Nagpur integration and infrastructure development justifies pursuing **twin city planning strategies**.

Transit-Led Urban Growth

- A high preference for **metro/light rail systems** validates proposals for RMTS.
- Integrated last-mile connectivity with **roads and rail** is essential.

Balanced Industrial Ecosystem

- Support for **manufacturing, agro, textile, pharma, and IT** enables the formation of a **multi-sectoral economic hub**.

Sustainability and Equity

- Emphasis on **green spaces, public amenities**, and **environmental safeguards**.

- Planning must promote **inclusive growth** that addresses economic, environmental, and social dimensions.

Conclusion

This extensive public input forms the backbone for a strategic plan that is **grounded in community needs and aspirations**. The data highlights a cohesive vision: one that embraces **connectivity, inclusivity, industrial diversity, and environmental responsibility**—guiding Wardha's transition into a dynamic twin city complementing Nagpur.

CHAPTER 7
STRATEGIC PLANNING INTENT

7.1 Vision Statement

"To develop Wardha as a strategic and supportive twin city to Nagpur by optimizing land use, strengthening multimodal connectivity, and decentralizing pressure from Nagpur's core—enabling balanced regional growth through integrated spatial zoning, infrastructure synergy, and economic diversification."

7.2 Urban Integration Strategy

The Urban Integration Strategy for developing Wardha as a twin city to Nagpur is centered around four core principles: functional synergy, enhanced connectivity, economic decentralization, and livability. These elements are strategically aligned with national missions such as PM Gati Shakti, Make in India, Smart Cities Mission, and the National Education Policy (NEP 2020).

- **Overall Strategy**: Establish Wardha as a functionally integrated counterpart to Nagpur, addressing overspill in logistics, industry, and institutional services.
- **Connectivity**: Improve highway and rail networks to achieve a 45-60 minute commute between the cities. Transport integration will leverage rail, road, and Samruddhi Mahamarg infrastructure.
- **Economic Decentralization**: Divert industrial, logistics, and institutional expansions from Nagpur to Wardha to alleviate urban stress.
- **Livability**: Introduce mixed-use zoning near institutions and commercial zones to promote walkability and vibrant urban environments.

7.3 Strategic Zoning Framework

To implement the urban integration strategy, specific planning intents have been defined for various zoning typologies within Wardha.

7.3.1 Institutional Zone

- **Intention**: Reinforce Wardha's identity as an educational and healthcare support city.
- **Actions**:
    - Establish new universities, medical and research institutions.
    - Create an education and knowledge corridor to absorb spillover demand from Nagpur.
    - Ensure proximity to highways for improved accessibility.

7.3.2 Logistics Zones

- **Intention**: Develop high-capacity logistics infrastructure to decongest Nagpur.
- **Actions**:
    - Establish regional warehousing and cold chain hubs on Wardha's periphery.
    - Leverage Samruddhi Mahamarg and NH-361 for north-side connectivity.
    - Use Sindhi rail and highway links for east-side industrial support.

7.3.3 Commercial Zones

- **Intention**: Support Wardha's emergence as a secondary commercial core.
- **Actions**:
    - Concentrate commercial activity near major transport junctions.
    - Enable high-intensity retail, office, and service sectors.
    - Function as a retail and business extension of Nagpur CBD.

7.3.4 Industrial / Textile Park (South)

- **Intention**: Leverage Wardha's industrial base for economic specialization.
- **Actions**:
    - Enhance textile, agro-processing, and export-oriented manufacturing.
    - Strengthen connectivity to Ballarshah, Deoli, and rail networks.
    - Promote employment generation and backward linkages to logistics and SEZ zones.

7.3.5 Special Economic Zones (SEZ)

- **Intention**: Position Wardha as a hub for export-oriented industries.
- **Actions**:
    - Attract FDI and national investments.
    - Promote IT, electronics, and biotechnology sectors.
    - Link SEZ zones with plug-and-play logistics and industrial infrastructure.

7.3.6 New Road / Ring Road (Southern Link)

- **Intention**: Support decongestion and enable regional transport flows.
- **Actions**:
    - Create peripheral transport connectivity with Samruddhi Mahamarg and Wardha Railway Station.
    - Enhance regional and intra-city mobility.

7.3.7 Transport Interchanges (Nodes)

- **Intention**: Develop nodal transit hubs integrating all transport modes.
- **Actions**:
    - Connect industrial, SEZ, and logistics centers to highways and rail.
    - Facilitate seamless passenger and goods movement.

7.4 Strategic Alignment with National Policies

The proposed strategy aligns strongly with several national initiatives:

- **PM Gati Shakti**: Establishment of multimodal logistics parks and MMLPs.
- **Make in India**: Promotion of SEZs and export-oriented industrial hubs.
- **Smart Cities Mission**: Digital and infrastructural integration of transport utilities.
- **NEP 2020**: Expansion of institutional hubs and education corridors.

7.5 Conclusion

The strategic plan to develop Wardha as a twin city to Nagpur encapsulates a multidimensional vision anchored in functional synergy, economic balance, and integrated connectivity. By implementing targeted zoning, enhancing transport infrastructure, and fostering sector-specific growth, the plan lays the foundation for Wardha to emerge as a dynamic urban node within the Vidarbha region. This transformation will not only decentralize urban pressure from Nagpur but will also catalyze regional development, making the twin-city model a scalable template for similar urban agglomerations in India.

CHAPTER 8
PROPOSALS AND RECOMMENDATION

8.1 Recommendation - 1

Transport Infrastructure and Connectivity for Twin City Integration

8.1.1 Introduction

The success of developing Wardha as a twin city to Nagpur hinges significantly on strengthening physical connectivity. Efficient transportation infrastructure not only enhances mobility but also plays a catalytic role in promoting economic decentralization, improving livability, and fostering integrated regional development. This chapter outlines key transit-oriented interventions — particularly the extension of the Nagpur Metro to Butibori and the recommendation of Rapid Mass Transit System (RMTS) corridor — and evaluates their transformative potential for the Nagpur–Wardha urban continuum.

8.1.2 Existing and Planned Transport Connectivity

Nagpur Metro Extension to Butibori (Phase II)

The ongoing extension of the Nagpur Metro upto Butibori represents a strategic enabler for regional mobility. Butibori, located southwest of Nagpur and situated along the corridor toward Wardha, serves as a critical node. Its integration into the metro network lays the groundwork for future expansion towards Wardha via a rapid transit system.

- **Executing Agency:** Maharashtra Metro Rail Corporation Ltd. (Maha Metro)
- **Project Milestones:**
    - DPR completed in 2019
    - Approved by Railway Board and Maharashtra State Cabinet in 2020
    - Implementation timeline: 24 months post-MoU signing
    - As of 2025, the project is in pre-execution phases with a revised target for completion by late 2025

Recommended RMTS Corridor: Nagpur – Butibori – Sindi – Wardha

Recommended RMTS corridor builds on the momentum of the metro extension. It connects key urban and economic nodes — including Butibori, Sindi Dry Port, and Wardha — into a cohesive rapid transit network.

- **Proposed Route:** Nagpur → Butibori → Sindi → Wardha
- **Mode:** Broad Gauge Metro or RMTS
- **Strategic Nodes:**
    - **Butibori:** Existing industrial zone with metro access
    - **Sindi Dry Port:** A logistics and freight hub that will benefit from improved multimodal access
    - **Wardha:** Emerging institutional and residential center with growing commuter needs

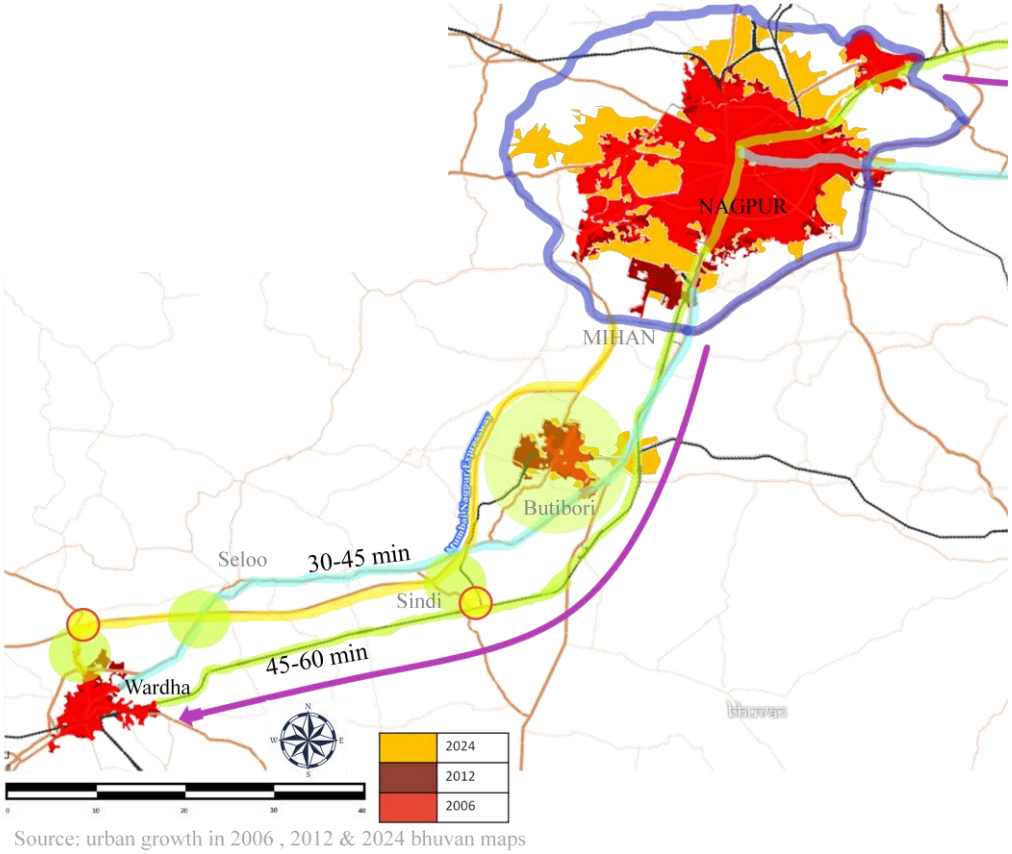


Figure 23 Existing connectivity in between Nagpur and Wardha with nodes like Butibori and Sindi

8.1.3 Strategic Benefits of RMTS Corridor

- **Freight + Passenger Synergy:** Shared infrastructure enhances cost-efficiency and land-use optimization.
- **Logistics Decongestion:** Diverts freight from Nagpur's core, reducing congestion and emissions.
- **Economic Stimulus:** Boosts industrial activity in Sindi and Wardha; encourages investment in warehousing, manufacturing, and allied services.
- **Supports Polycentric Growth:** Aligns with Maharashtra's smart growth strategy by creating multiple functional urban centers.

8.1.4 Demand Projections and Mode Suitability

Based on commuter analysis and urban growth trends, the RMTS corridor is justified in terms of both current and projected ridership.

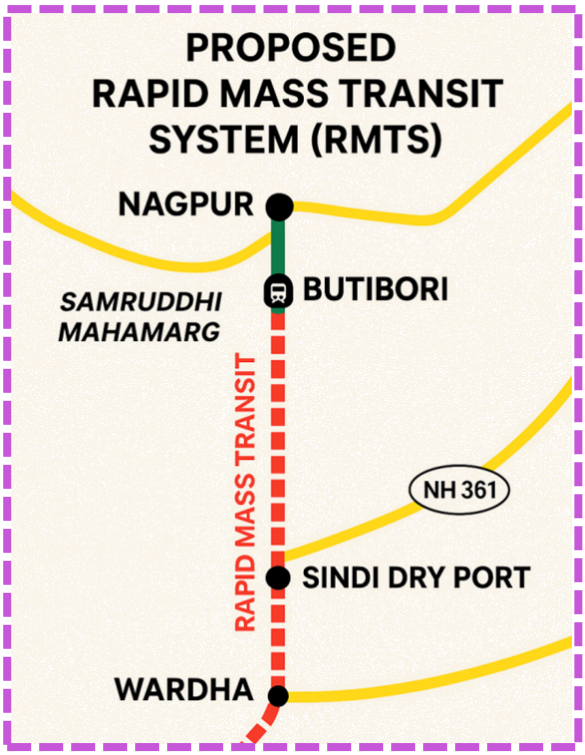


Figure 24 Proposed RMTS Route

Commuter Base and Growth Factor

- **Estimated Daily Commuters (2025):** 25,000–32,000 (one-way) on basis of population[31]

Symbol	Meaning	Wardha–Nagpur
Present Demand	Current number of commuters	32,000 daily commuters
r	Annual growth rate	3% = 0.03
n	Number of years in the future	20 years (2025 to 2045)
(1 + r)^n	Growth multiplier	(1.03)^20 = 1.806

- **Growth Factor (10–20 years)**

Using a moderate **growth rate of 2.5–3.5% per annum** for urban travel due to:
Samruddhi Mahamarg
Proposed interchanges
Industrial + Institutional growth
Population growth & motorization
Use the formula:
Future Demand = Present × (1 + r)^n
Let's project for **2045 (20 years)** with r = 3%
→ Future Commuters = 32,000 × (1.03)^20 = 50,000 – 57,800

- **Growth Rate:** 2.5%–3.5% annually, factoring in:
    - Samruddhi Mahamarg influence
    - Industrial and institutional expansion
    - Interchange and metro connectivity improvements
- **Projected Demand by 2045:**
    - **Daily Ridership (one-way):** 50,000–57,800
    - **Peak Hour Load:** 5,000–8,000 passengers/hour
    - **Mode Split (assumed):**
        - Rail: 35–45%
        - Bus: 30–40%
        - Private Vehicles: 15–20%
        - Shared/Other: 5–10%

Transport Mode Suitability

Mode	**PHPDT Threshold**	**Suitable For**
Bus Service	Up to 5,000	Small cities
BRT	5,000–15,000	Medium demand
Light Rail Transit (LRT)	**10,000–30,000**	**High but sub-metro demand**
Metro Rail (RMTS)	**20,000–60,000+**	**Large cities**

Table 20 Transport Category with respect to PHPDT[32]

Given the projected demand and urban scale, either **LRT** or **Metro Rail (RMTS)** is appropriate for the Nagpur–Wardha corridor. The RMTS model offers higher capacity and integrates well with existing railway infrastructure.

8.1.5 Policy and Planning Alignment

The proposed transit strategies are well-aligned with national and state-level initiatives:

- **PM Gati Shakti:** Enhances freight mobility through logistics parks and MMLPs
- **Make in India:** Supports SEZs and industrial development
- **National Education Policy (NEP 2020):** Strengthens educational integration via improved access
- **Smart Cities Mission:** Fosters digital and transport integration
- **Maharashtra State Urban Transport Policy:** Encourages multimodal, sustainable transit solutions

8.1.6 Conclusion

The integration of a Rapid Mass Transit System between Nagpur and Wardha is not merely a transport intervention but a strategic development lever. It enhances accessibility, decongests urban cores, stimulates local economies, and fosters balanced regional growth. As a backbone of the twin-city strategy, the RMTS corridor — supported by metro extensions and dry port logistics — positions the Nagpur–Wardha axis as a future-ready economic and transportation hub in Maharashtra.

8.2 Proposal – 1

Strategic Land Use Integration

8.2.1 Overlapping Land Use with Suitability Analysis

An overlay of Wardha's land use with land suitability analysis reveals key zones with development potential:

- **Northern and Northeastern Corridor** (near Samruddhi Mahamarg): Best suited for logistics
- **Western and Southern Zones**: Suitable for institutional and industrial expansion respectively
- **Central Wardha**: Remains optimal for commercial or mixed use densification

Transport corridors such as NH-361, Samruddhi Mahamarg, and multiple railway lines reinforce these land use decisions, enhancing accessibility.

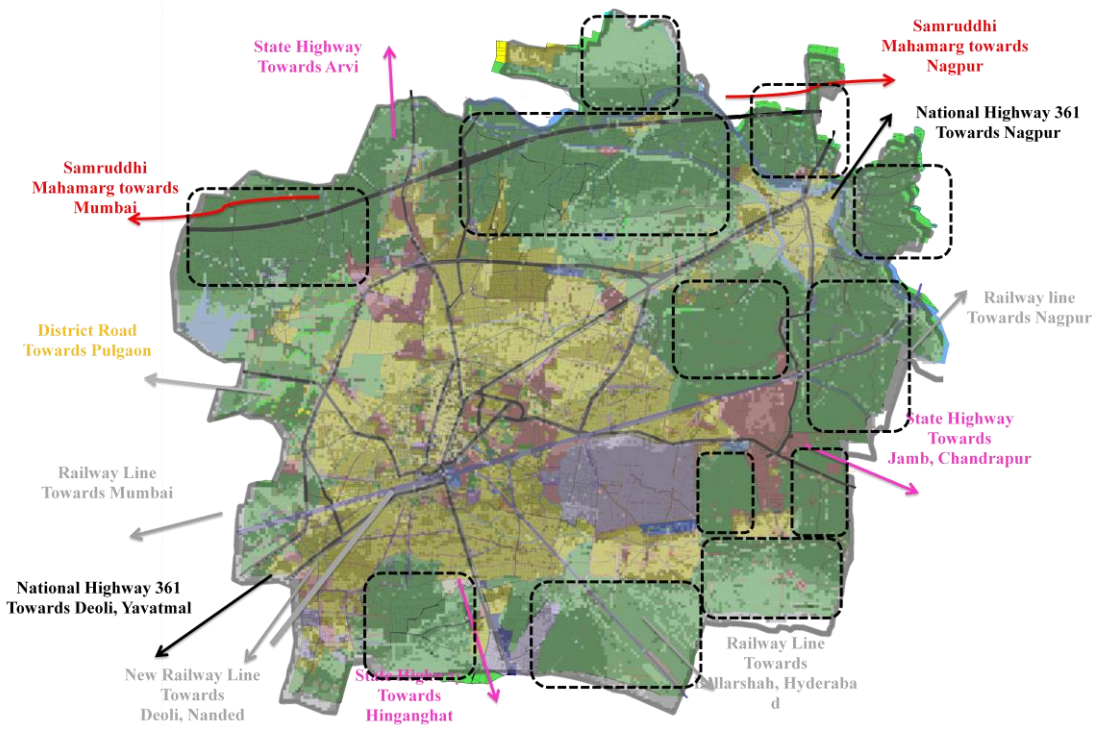


Figure 25 Overlapping of Land Suitability Map on Existing Landuse

8.2.2 Zone Proposals

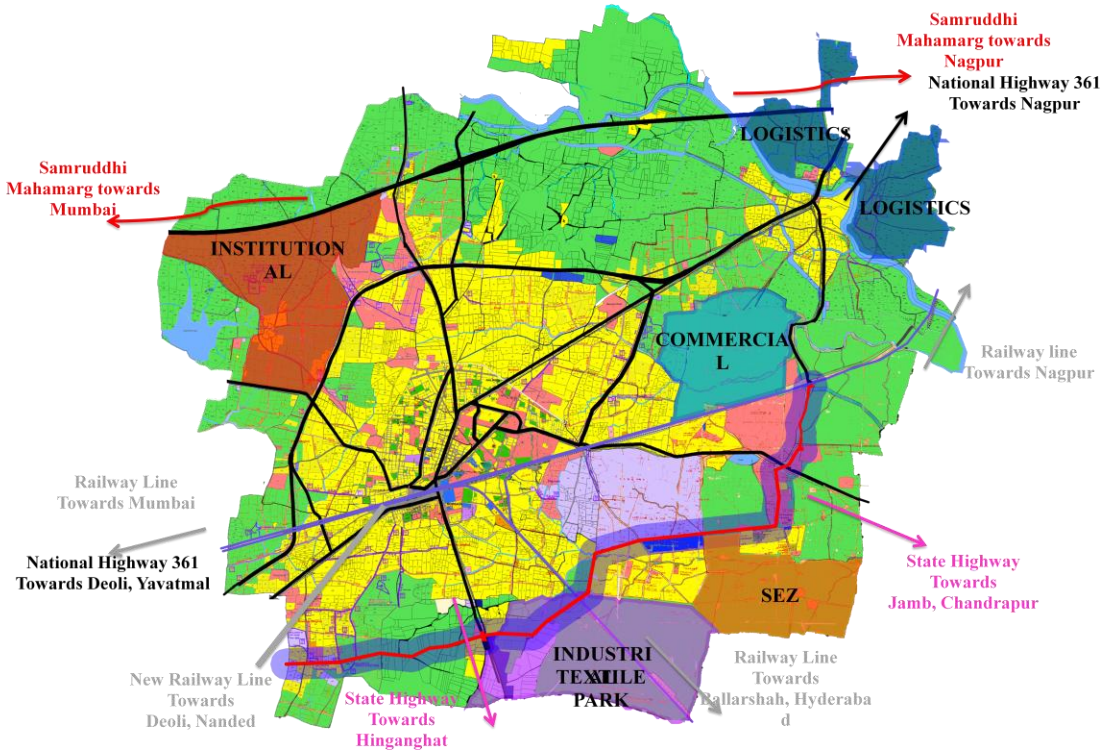


Figure 26 Proposed Zone for integrated landuse

1 Logistics Zone (Approx. 6 sq. km)

Located near NH-361 and Samruddhi Mahamarg, the logistics zone leverages proximity to highways and the proposed dry port at Sindi. Its positioning avoids existing residential areas, aligning with freight efficiency goals.

2 Institutional Zone (Approx. 8 sq. km)

Proposed near existing educational clusters, particularly in the west, this zone benefits from adjacency to residential areas and highway access, promoting accessibility for students and staff.

3 Commercial Zone (Approx. 5 sq. km)

Planned in the central city, near major road junctions and the railway line, this zone capitalizes on urban density and high footfall, making it ideal for retail, offices, and mixed-use development.

4 Industrial & Textile Park (Approx. 10 sq. km)

Situated in the south, adjacent to Ballarshah-Hyderabad rail corridor and new Deoli-Nanded line, this zone is designed to consolidate industrial activity and catalyze employment.

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5 Supporting Infrastructure: Ring Road and Road Widening

The southern ring road is proposed to link industrial, logistics, and SEZ areas with arterial highways, reducing freight pressure on the urban core and improving internal circulation.

---

6 Strategic Implications

- **Polycentric Growth**: Ensures balanced development between Nagpur and Wardha
- **Modal Shift Promotion**: Encourages use of rail/bus over private vehicles
- **Economic Decentralization**: Stimulates economic activity along the RMTS corridor
- **Land Use Efficiency**: Aligns zoning with transport capacity and suitability

---

8.3 Proposed Detail of Logistic Zone

8.3.1 Logistics Zone – 6.0 Sq. Km (600 Ha)

The proposed logistics zone is strategically located in northeast part of Wardha, adjacent to the Samruddhi Mahamarg and the upcoming freight corridors. The zone is purposefully designed to serve as a critical logistics and warehousing hub supporting the dry port at Sindi and the RMTS corridor connecting Wardha and Nagpur.

Design Characteristics (Based on Map Layout):

- **Total Area:** 600 Ha (6.0 Sq. Km)
- **Total Plot Area:** 365 Ha
- **Total Road Network Area:** 84 Ha
- **Open Space Provision:** 90 Ha
- **Public Amenities:** 47 Ha
- **Commercial Area Allocation:** 14 Ha

Road Hierarchy:

- **Arterial Roads:** 60.00 m wide – facilitating high-speed movement of freight and heavy vehicles
- **Tributary Roads:** 30.00 m wide – distributing traffic to individual logistics plots and support services

Sector Typology:

- **Sector Type A:** 200 m × 150 m – ideal for medium-size logistics operators
- **Sector Type B:** 200 m × 200 m – suited for large godowns or centralized warehousing
- **Sector Type C:** 200 m × 300 m – suitable for multi-modal freight centers

- **Sector Type D:** 200 m × 400 m – for integrated logistics parks or bonded warehouses

Functional Components:

- **Core Warehousing Units** dominate the central spine, maximizing access to arterial roadways.
- **Public amenities and open spaces** are integrated within walking distance of most plots, ensuring environmental quality and worker welfare.
- **Commercial nodes** (14 Ha) are distributed along primary intersections, offering service centers, logistics tech offices, vehicle maintenance depots, and dining/rest facilities.
- **Green buffers and water retention zones** are placed along the southern and western peripheries, addressing drainage and environmental sustainability.

Strategic Advantages:

- **Proximity to major freight infrastructure**: Samruddhi Mahamarg, NH-361, Deoli-Nanded rail line
- **Cluster-based planning**: Consolidates logistics operations into a single, regulated ecosystem
- **Scalability**: The modular plot sizes allow phased development and attract a variety of stakeholders (MSMEs to MNCs)

Impact on Twin-City Vision:

- Positions Wardha as a **freight convergence node** between Vidarbha and Marathwada
- **Reduces freight pressure on Nagpur's urban core**
- Attracts logistics investments and **stimulates job creation**
- Provides spatial support to the **RMTS corridor**, ensuring freight and passenger movement synergy

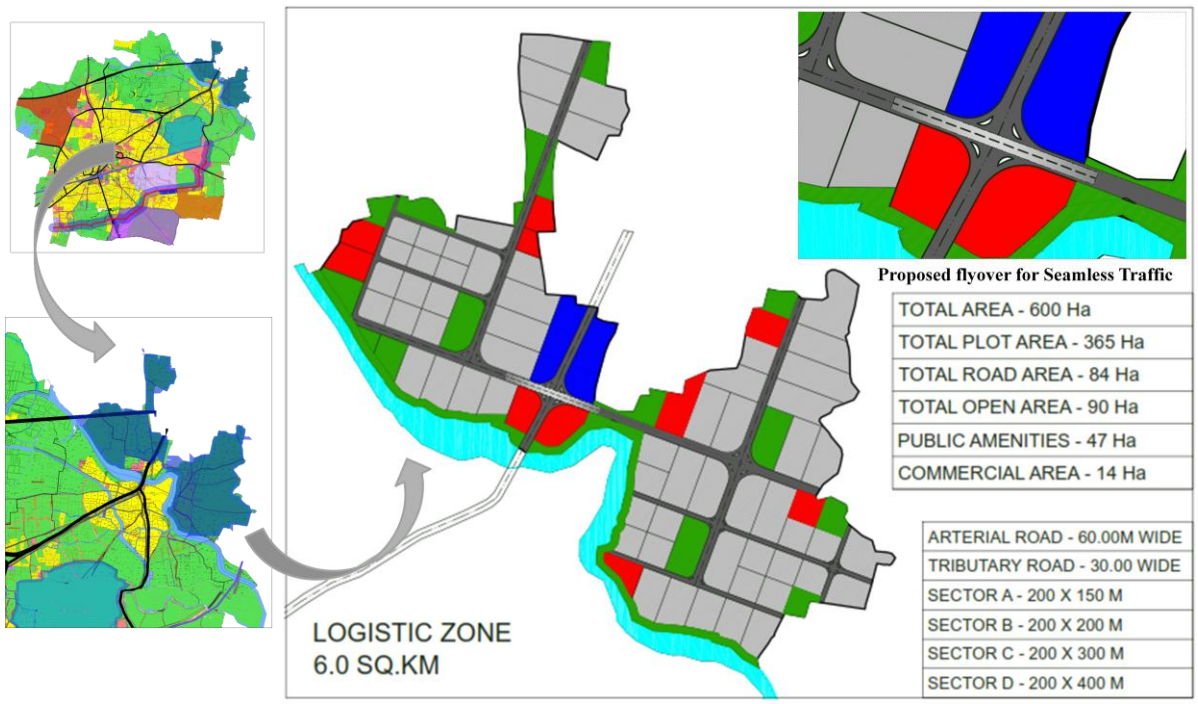
Proposed flyover for Seamless Traffic
TOTAL AREA - 600 Ha
TOTAL PLOT AREA - 365 Ha
TOTAL ROAD AREA - 84 Ha
TOTAL OPEN AREA - 90 Ha
PUBLIC AMENITIES - 47 Ha
COMMERCIAL AREA - 14 Ha
ARTERIAL ROAD - 60.00M WIDE
TRIBUTARY ROAD - 30.00 WIDE
SECTOR A - 200 X 150 M
SECTOR B - 200 X 200 M
SECTOR C - 200 X 300 M
SECTOR D - 200 X 400 M
LOGISTIC ZONE
6.0 SQ.KM

Figure 27 Detail of Logistic zone

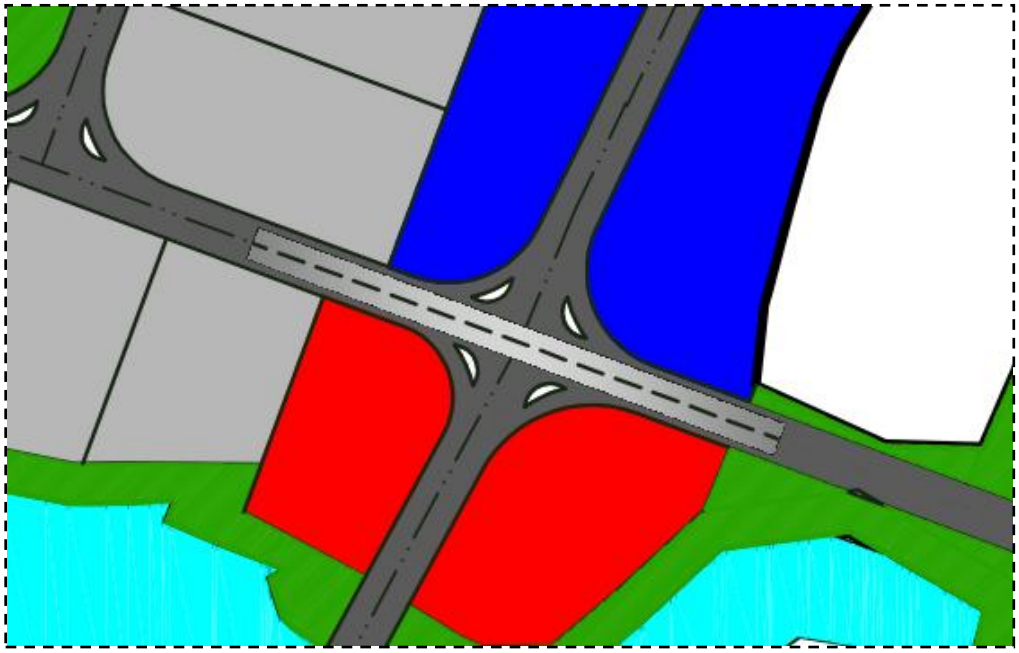

Figure 28 Proposed flyover for seamless traffic

8.4 Proposal – 2

Strategic Development of Interchange Hubs

The proposal for developing multimodal interchange hubs plays a pivotal role in operationalising the spatial and functional integration between Wardha and Nagpur. These hubs are designed as strategic nodes that support seamless connectivity between regional, intercity, and intra-city travel modes—ultimately catalyzing a modal shift towards sustainable public transportation.

8.4.1 Rationale and Strategic Objectives

The integration of transfer hubs aligns with the broader vision of fostering a **polycentric urban structure**, reducing dependency on Nagpur's core, and enhancing accessibility to peripheral regions such as Wardha. The spatial planning rationale for these hubs is based on three key criteria:

1. **Strategic Location**
   Each hub is located along high-capacity corridors such as NH-44, SH-3, and planned metro or BRT routes. This positions them at intersections of radial and orbital mobility networks, ensuring regional reach and ease of access.
2. **Connectivity Potential**
   The hubs are situated at convergence points of primary and secondary roads, allowing for multimodal integration between buses, intermediate public transport (IPT), future RMTS (Regional Mass Transit System), and metro connectivity. Their function is not just to facilitate transfers but to anchor compact urban development.
3. **Surrounding Land Use**
   These hubs are embedded within mixed-use zones characterized by residential, commercial, and institutional functions. This land-use composition ensures consistent footfall, supports last-mile connectivity, and promotes transit-oriented development (TOD).

8.4.2 Functional Typologies of Proposed Hubs

The map identifies two primary categories of hubs:

- **Inter-City Transfer Hub (Central Node):**
  Located near the interface of Wardha's urban core and the Nagpur-Wardha corridor, this hub facilitates high-volume intercity movement and long-haul regional traffic. It will function as a terminal node for RMTS and intercity buses, with potential integration into a future regional rail or metro corridor.
- **Intra-City Transfer Hubs (Peripheral Nodes):**
  These five hubs are distributed at nodal intersections of urban sub-centers. They are envisioned as feeder nodes to support radial-transit flows, integrate IPT networks, and act as convergence points for employment and institutional zones in a decentralized manner.

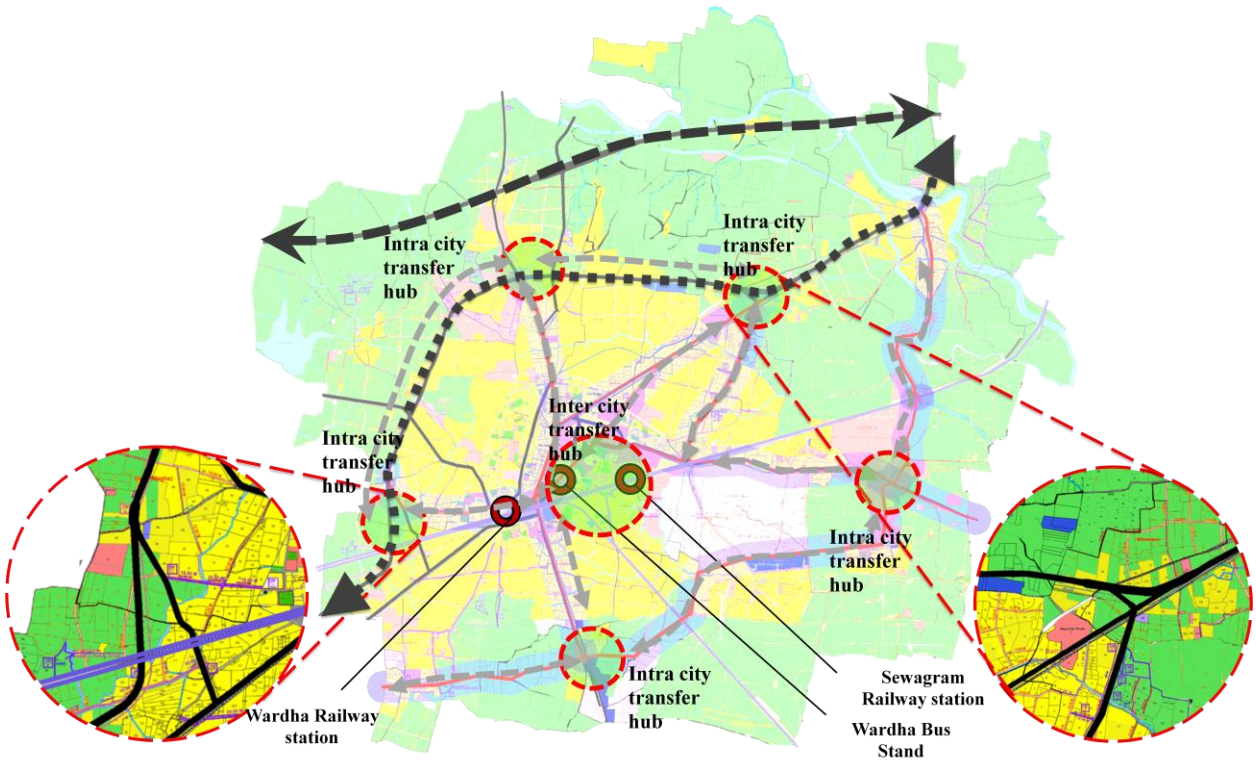

Figure 29 Proposed Interchange

8.4.3 Expected Outcomes and Urban Benefits

- **Modal Shift Enablement:**
  The transfer hubs reduce reliance on private vehicles by offering seamless transitions between modes.
- **Decongestion of Core Areas:**
  By decentralizing commuter interchange functions, traffic concentration in central Nagpur and Wardha is reduced.
- **Catalyst for TOD and Urban Expansion:**
  Surrounding land can be zoned for high-density, mixed-use, and affordable housing, promoting compact and accessible neighborhoods.
- **Resilient and Adaptive Transport Structure:**
  These hubs serve as flexible nodes adaptable for future transit upgrades like electric bus corridors, metro extensions, and logistics linkages (dry port).

8.4.4 Linkage with Broader Twin City Strategy

This proposal is deeply interlinked with the strategic intent of positioning Wardha as a **functional Twin city to Nagpur**, with shared responsibilities in housing, employment, and logistics. The proposed interchange hubs are not standalone interventions but spatial anchors that integrate land use, mobility, and infrastructure investments to balance regional development.

8.5 Proposal - 3

Design model of Intra-City Transfer Hub in Wardha

To operationalize the spatial integration plan at the micro level, Proposal 3 focuses on the **physical planning and implementation of a 15-hectare intra-city transfer hub** in Wardha. Located strategically near the **Sewagram Railway Station** and **NH 361**, the site offers excellent regional and local accessibility. This transfer hub design is based on passenger demand forecasts (~58,000 daily users by 2045), modal share analysis, and potential for future multimodal integration.

8.5.1 Types of Transfer Hub:

Scale	Tentative Area	Features
Local	0.2 – 1 hectare(2,000 – 10,000 m²)	4–10 bus bays, taxi ranks, shelters, pedestrian access
Regional	1 – 5 hectares(10,000 – 50,000 m²)	10–30 bus bays, train platforms, parking, waiting & ticketing areas
National	5 – 20 hectares(50,000 – 200,000 m²)	Intercity bus/rail terminals, large concourses, retail, multiple platforms
Inter national	20 – 100+ hectares(200,000 – 1,000,000+ m²)	Airports, seaports, customs, metro/high-speed rail links, freight zones

Table 21 Types and Scale of Interchange[33]

8.5.2 Area Requirements for a Major Inter-City Transfer Hub

Component	Area Range	Notes
Bus Terminal	2–4 ha	10–20 bays, idle parking, circulation space
Railway Terminal	5–8 ha	For 4–6 platforms, waiting areas, back-end ops
Multimodal Concourse (waiting + circulation)	1–2 ha	Ticketing, concourse, info, passenger flow
Retail/Commercial Space	1–2 ha	Food courts, shops, kiosks, service areas
Parking (bus, car, two-wheeler, taxi)	1–1.5 ha	Based on peak-hour demand and modal mix
Green/Open/Utility Buffer	1–2 ha	Landscaping, NMT paths, future expansion, utility zones

Table 22 Requirement for Major Interchange[34]

8.5.3 Area Requirements for a Minor Intra-City Transfer Hub

Component	Area Range	Notes
Intra city Bus Terminal	1–2 ha	5–10 bays, idle parking, circulation space
Retail/Commercial Space	1–2 ha	Food courts, shops, kiosks, service areas
Parking (bus, car, two-wheeler, taxi)	1–1.5 ha	Based on peak-hour demand and modal mix
Green/Open/Utility Buffer	1–2 ha	Landscaping, NMT paths, future expansion, utility zones

Table 23 Requirements for Minor Interchange[34]

8.5.4 Key Components and Justification:

1. **Intra-city Bus Terminal (3.5 ha)**:
    - Designed for 5–10 bus bays with idle parking and turnaround space.
    - Serves local and regional bus routes including RMTS links to Nagpur.
    - Reduces transfer times and congestion at isolated bus stops.
2. **Retail/Commercial Space (2.5 ha)**:
    - Offers convenience retail, kiosks, and food courts.
    - Generates revenue and enhances commuter experience.
    - Anchors TOD (Transit Oriented Development) around the hub.
3. **Auto and Taxi Stand (2.0 ha)**:
    - Provides organized pick-up/drop zones for autos and taxis.
    - Addresses last-mile connectivity in surrounding localities.
4. **Multimodal Parking (2.0 ha)**:
    - Facilitates park-and-ride options with provisions for two-wheelers, cars, and buses.
    - Designed based on peak-hour demand and projected modal mix.
5. **Green/Open/Utility Buffer (2.5 ha)**:
    - Incorporates landscaping, NMT (non-motorized transport) corridors, and buffer areas.
    - Supports environmental sustainability and future infrastructure flexibility.

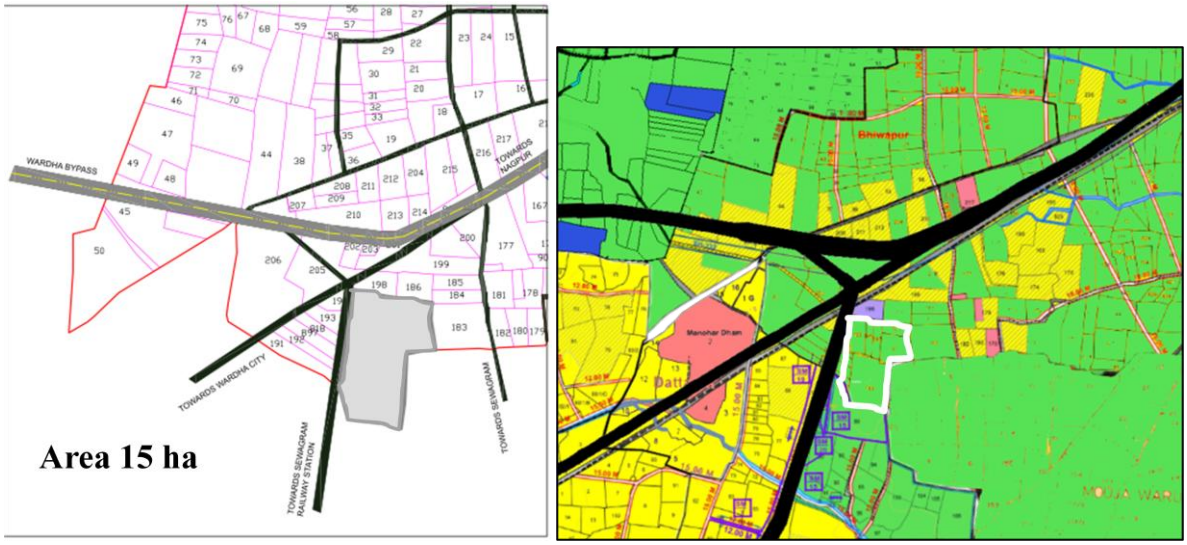

Figure 30 Identified land for Minor Interchange

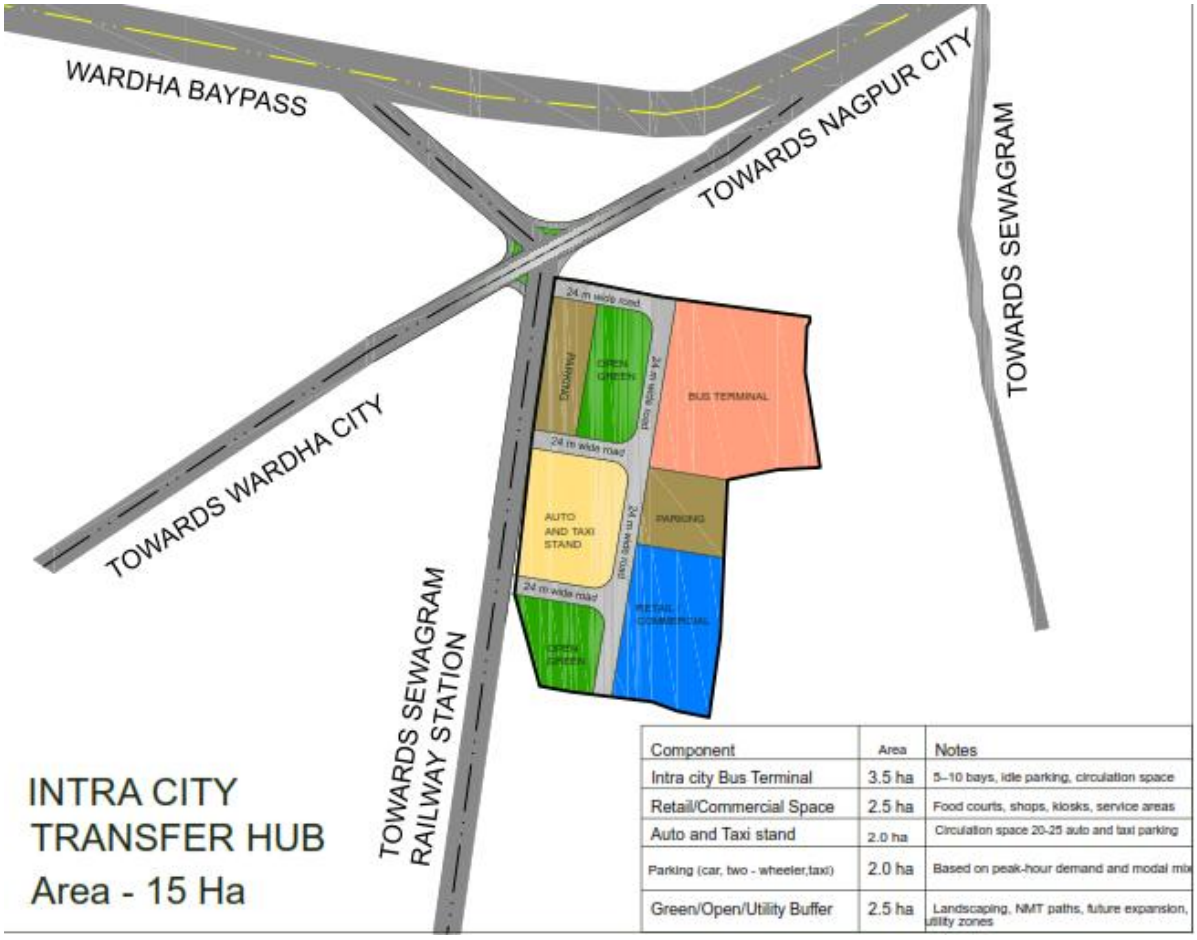
WARDHA BAYPASS
TOWARDS NAGPUR CITY
TOWARDS SEWAGRAM
TOWARDS WARDHA CITY
TOWARDS SEWAGRAM RAILWAY STATION
24 m wide road
BUS TERMINAL
PARKING
AUTO AND TAXI STAND
RETAIL COMMERCIAL
INTRA CITY TRANSFER HUB
Area - 15 Ha
Component | Area | Notes
Intra city Bus Terminal | 3.5 ha | 5–10 bays, idle parking, circulation space
Retail/Commercial Space | 2.5 ha | Food courts, shops, kiosks, service areas
Auto and Taxi stand | 2.0 ha | Circulation space 20-25 auto and taxi parking
Parking (car, two - wheeler,taxi) | 2.0 ha | Based on peak-hour demand and modal mix
Green/Open/Utility Buffer | 2.5 ha | Landscaping, NMT paths, future expansion, utility zones

Figure 31 Planning of Minor Interchange

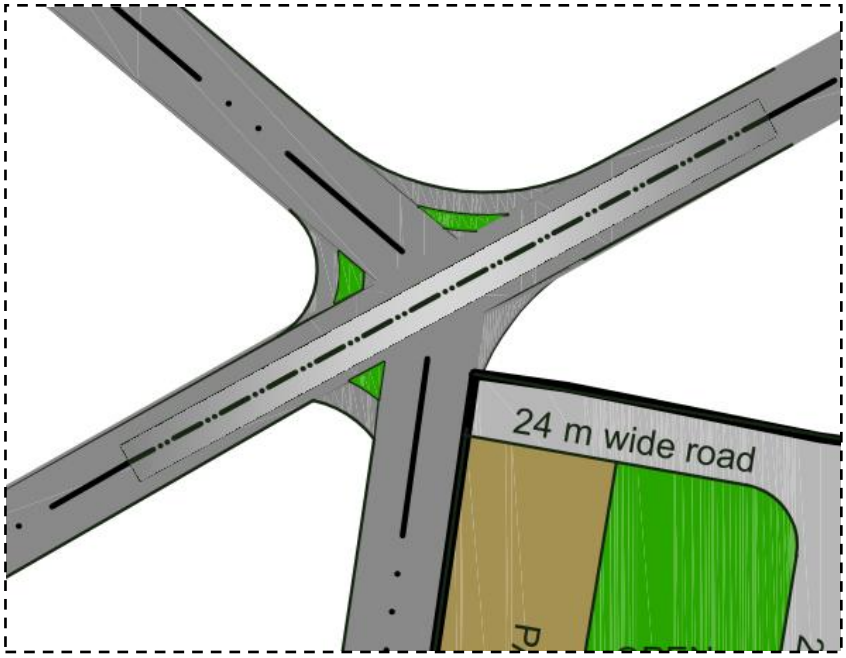

Figure 32 Proposed flyover for Seamless Traffic

The proposal also aligns with **national transport terminal guidelines** ensuring scalability for regional/national functions in the long term. The site's location near key transport corridors allows it to evolve into a **regional mobility anchor** and catalyze **economic decentralization** from Nagpur to Wardha.

8.5.5 Conclusion

Together, Proposals 2 and 3 form a critical foundation for achieving **multi-nodal urban integration** between Wardha and Nagpur. While Proposal 2 lays out the broader network of interchange hubs, Proposal 3 translates that strategy into a tangible infrastructure intervention. These hubs are more than just transit points—they are **urban catalysts** that will foster **sustainable growth**, **economic synergy**, and **regional equity** in the twin city framework.

CHAPTER 9
FINAL CONCLUSION

This thesis articulates a comprehensive strategic framework for the spatial and functional integration of Wardha as a twin city to Nagpur, addressing the critical regional challenges of urban congestion, economic concentration, and transportation inefficiencies within the Nagpur Metropolitan Region. By assessing current infrastructural shortcomings, forecasting growth trajectories, and examining mobility patterns, the study positions Wardha as a viable and sustainable urban node for regional decentralization, economic diversification, and improved connectivity.

The GIS-based land suitability analysis, proposed zoning strategies, and phased development plans offer a practical and scalable roadmap for implementation. These proposals are further reinforced by policy alignment, stakeholder input, and public survey feedback, ensuring their contextual relevance and feasibility.

Employing a multi-scalar approach—from regional mobility planning to localized urban design—the thesis recommends a series of targeted interventions to strengthen transportation networks, align land-use patterns, and foster institutional collaboration. Key components of this strategy include the establishment of multimodal transit hubs, the integration of Regional Mass Transit Systems (RMTS) and extended metro corridors, and the implementation of Transit-Oriented Development (TOD) to promote compact, accessible, and sustainable urban environments.

The planned development of dedicated industrial and institutional zones, informed by spatial data analysis, addresses the need for balanced economic distribution. While challenges such as fragmented governance, infrastructure gaps, and environmental limitations persist, they can be effectively managed through integrated regional planning and active stakeholder participation.

In summary, this thesis proposes a holistic model for twin city development, where Wardha is envisioned not as a subordinate satellite, but as a complementary urban center with its

own economic base, resilient transit infrastructure, and collaborative governance structure. The outcomes offer valuable insights for policymakers, urban planners, and researchers aiming to foster polycentric growth and regional resilience in India's rapidly urbanizing landscape.

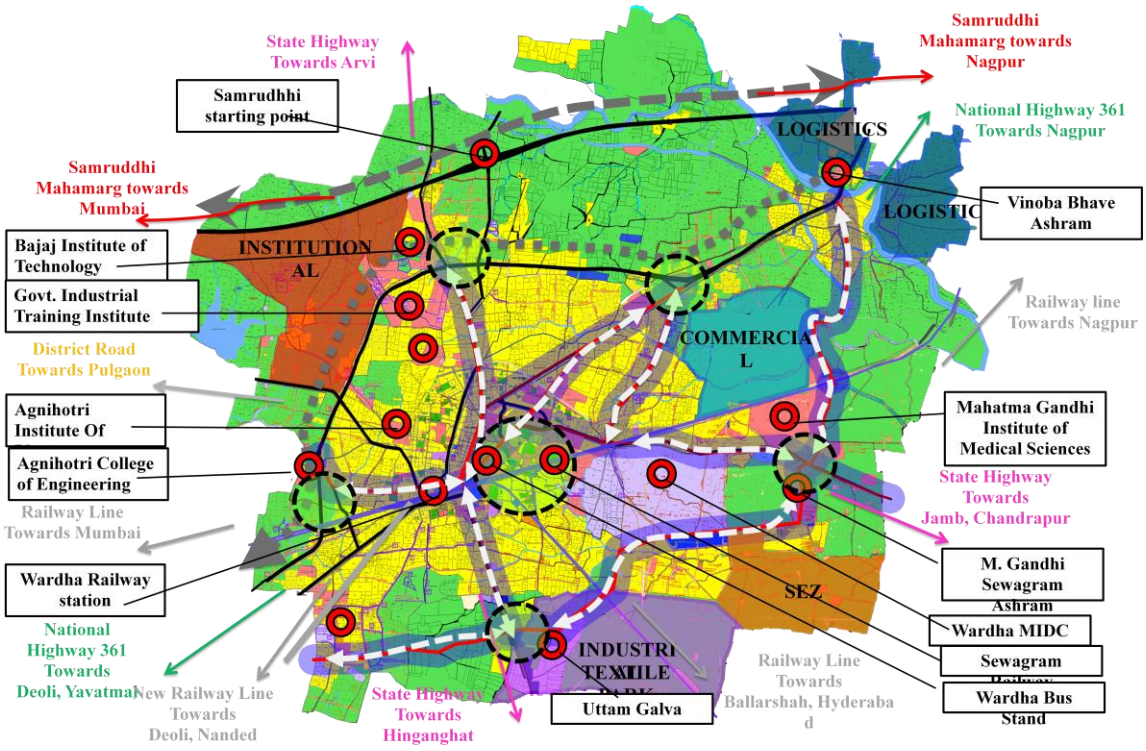

Figure 33 Master plan

CHAPTER 10
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